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(c) Paragraphs 4.1 and 1.2.3.1 of AFSSD Exhibit 61-27A

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Title	Number and Date
Human Factors Engineering Special Programs and Program 461 Final Report	WDL-TR2007 11 February 1963

PHILCO CORPORATION
Western Development Laboratories

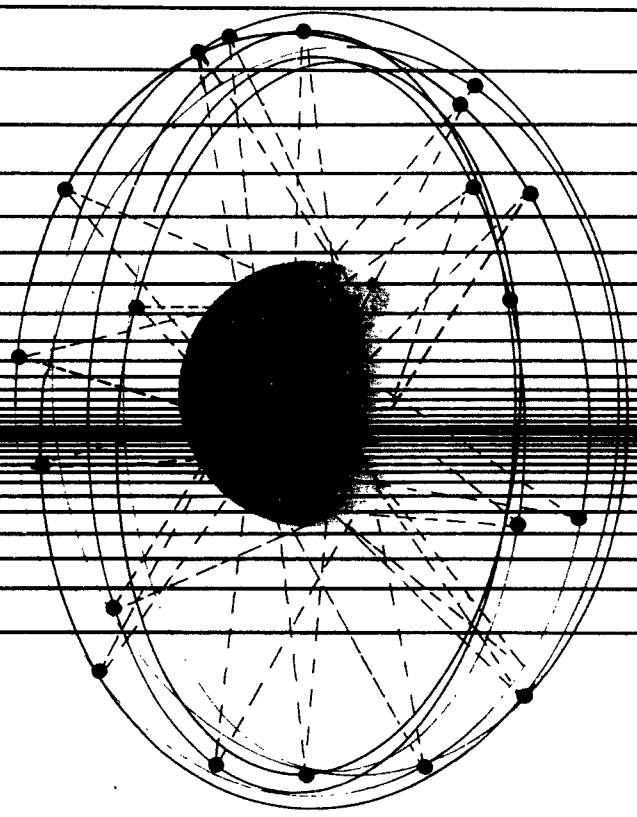
R. W. Boyd

R. W. Boyd
Manager, Contracts Management

TECHNICAL DOCUMENTARY REPORT

WDL-TR2007

11 FEBRUARY 1963



HUMAN FACTORS ENGINEERING SPECIAL PROGRAMS AND PROGRAM 461 FINAL REPORT

PREPARED FOR:

AIR FORCE SPACE SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
INGLEWOOD, CALIFORNIA

AF04(695) -113

PHILCO
A SUBSIDIARY OF Ford Motor Company

WESTERN DEVELOPMENT LABORATORIES
PALO ALTO, CALIFORNIA

TECHNICAL DOCUMENTARY REPORT

HUMAN FACTORS ENGINEERING SPECIAL PROGRAMS AND PROGRAM 461 FINAL REPORT

Prepared by

PHILCO CORPORATION
Western Development Laboratories
Palo Alto, California

Definitive Contract AF04(695)-113
AFBM Exhibit 58-1, Paragraph 3.16
AFSSD Exhibit 61-27A, Paragraphs 4.1 and 1.2.3.1

Prepared for

AIR FORCE SPACE SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
Inglewood, California

ABSTRACT

PHILCO WDL-TR2007 UNCLASSIFIED
HUMAN FACTORS ENGINEERING
SPECIAL PROGRAMS AND PROGRAM 461
FINAL REPORT pages
11 February 1963 Contract AF04(695)-113

This report summarizes the Human Factors Engineering effort for 1962 on Special Programs and Program 461. Significant tasks performed during the year include operability evaluations of station activities, control display designs, intracommunication network analyses, and layouts of work spaces.

THIS UNCLASSIFIED ABSTRACT IS DESIGNED FOR RETENTION IN A STANDARD 3-BY-5 CARD-SIZE FILE, IF DESIRED. WHERE THE ABSTRACT COVERS MORE THAN ONE SIDE OF THE CARD, THE ENTIRE RECTANGLE MAY BE CUT OUT AND FOLDED AT THE DOTTED CENTER LINE. (IF THE ABSTRACT IS CLASSIFIED, HOWEVER, IT MUST NOT BE REMOVED FROM THE DOCUMENT IN WHICH IT IS INCLUDED.)

FOREWORD

This Technical Documentary Report on Definitive Contract AF04(695)-113 has been prepared in accordance with Exhibit A of that contract and Paragraph 3.16 of AFBM 58-1, "Contractor Reports Exhibit," dated 1 October 1961, as revised and amended.

This report was prepared by Philco Western Development Laboratories in fulfilling the requirements of Paragraphs 4.1 and 1.2.3.1 of AFSSD Exhibit 61-27A, "Satellite Control Subsystem Work Statement," dated 15 February 1962, as revised and amended.

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SECTION 1
INTRODUCTION

1.1 HUMAN FACTORS ENGINEERING EFFORT

This report is a description of the Human Factors Engineering effort on Special Programs and Program 461 for the year 1962.

The human engineering effort, in compliance with MIL-STD-803 (USAF) "Human Engineering Criteria for Aircraft, Missile, and Space Systems Ground Support Equipment", dated 5 November 1959, consisted of a program to determine the operability and maintainability requirements of the system and individual equipment at VTS, NHS, and NPS.

The human engineering program comprised the following activities:

a. Human Factors Engineering assistance to equipment designers was provided in implementing changes and recommending or specifying hardware characteristics for control display equipment. In support of this effort, control display off-the-shelf hardware was evaluated to insure adequacy of hardware in meeting MIL-STD-803 requirements.

b. Proposed field modifications and engineering change orders were reviewed to determine adequacy of design, to provide a basis for modification of equipment or procedure, and to recommend remedial actions.

c. Station activities, control display design, and layout of work areas were monitored and evaluated to determine the adequecy of equipment and work areas in meeting operability objectives.

d. Field communication requirements and modifications were reviewed and revised to meet increased network loading. Problem areas and deficiencies which could degrade system effectiveness and require timely corrective action were identified.

e. System requirement studies were participated in to determine the flow and form of information and the decisions and actions for maintenance and operations. Feasible alternative ways for using human being and man-equipment combinations to meet system requirements were determined.

SECTION 2
INSTRUMENTATION AT NHS FOR PROGRAM 698BJ

2.1 HUMAN ENGINEERING DESCRIPTION

This study describes and analyzes the major man-machine interactions within the New Hampshire Station (NHS) during Program 698BJ prepass, orbit, and postorbit operations. The utilization of subsystems and equipment, including new support equipment peculiar to Program 698BJ, at NHS is also described. The major control and display consoles and their interface equipment are described in detail.

Console panel drawings were developed with a tabular listing of control display hardware, nomenclature, recommended vendor, function, and signal source. The flow of operations in terms of operator decision action sequences were also diagrammed for the console positions. Voice communications required to support operations and maintenance were discussed, and diagrams were developed to illustrate who talks to whom during the various phases of station activity.

The conclusion of the study included human engineering evaluations and recommendations. This study is being published separately.

SECTION 3
MAJOR OPERATING POSITIONS AT VTS AND NHS FOR PROGRAM 461

3.1 HUMAN ENGINEERING EVALUATION

The primary purpose of this study was to determine the adequacy of human engineering design of Program 461 equipment for major operating positions at VTS and NHS. The evaluation of design adequacy was based on present requirements for Program 461 support.

A secondary purpose of the study was to formulate recommendations for human engineering design improvements to be implemented during future site modification cycles. This study is being published separately.

SECTION 4

INSTRUMENTATION FOR VTS AND NHS TRACKING AND DATA CONSOLES

4.1 INTRODUCTION

This report consolidates the Human Factors Engineering design inputs for the Tracking and Data (T&D) consoles for Vandenberg Tracking Station (VTS) and New Hampshire Station (NHS). These inputs consist of panel layouts, cabinet configurations, panel hardware function lists, and operator decision/action flow diagrams.

The task of Human Engineering was to ensure that the console was designed for maximum operability with minimum chance for error. This was accomplished by studying the entire Tracking and Data system to determine the required control and display functions of the console by utilizing established psychological and physiological design principles and by conforming to the contractually binding Human Engineering design standard MIL-STD-803 (USAF).

The T&D consoles are the central control and monitoring locations for the 60-foot multipurpose antennas (formerly called the Data Receiving, or D/R, antennas) modified by WDL Technical Directives 156 (VTS) and 157 (NHS), Revision 2. According to Revision 2, the T&D antenna is capable of the following functions:

a. Receive on the 2.2-2.3 Gc band,

b. Receive on the 400 Mc band,

c. Receive on the 225-245 Mc band,

d. Doppler transmit on the 375 Mc band,

e. Command transmit on the 1.7-1.85 Gc band (less transmitter),

f. Autotrack on the 2.2-2.3 Gc band, and

g. Autotrack on the 400 Mc band.

In addition, it is possible to manually track signals in the 225-245 Mc band. Before the modification, the only function of the antenna was to receive on the 2.2-2.3 Gc band. However, at present, the only functions added to the tracking stations were according to Revision 1 of the modification. These were the range rate and autotrack capabilities of the two-way 400 Mc Doppler system. Some of the reasons why the modifications were made are:

a. To simplify the tracking station by reducing the amount of equipment, while retaining all the station capabilities,

b. To take advantage of the high gain and accuracy of the T&D antenna,

c. To accomplish the research and development necessary to provide multipurpose antennas for future systems,

d. To reduce the number of personnel, while maintaining the load capability of the station,

e. To increase the station reliability by reducing the amount of equipment,

f. To provide back-up for existing facilities, and

g. To simplify administration, checkout, and operating procedures.

A block diagram of the Multipurpose Antenna Subsystems is shown in Fig. 4-1. The diagram illustrates the relationship of the T&D console to the Multipurpose Subsystems. The antenna drive, boresight equipment, Doppler system, and UHF receivers are controlled and monitored for the T&D console.

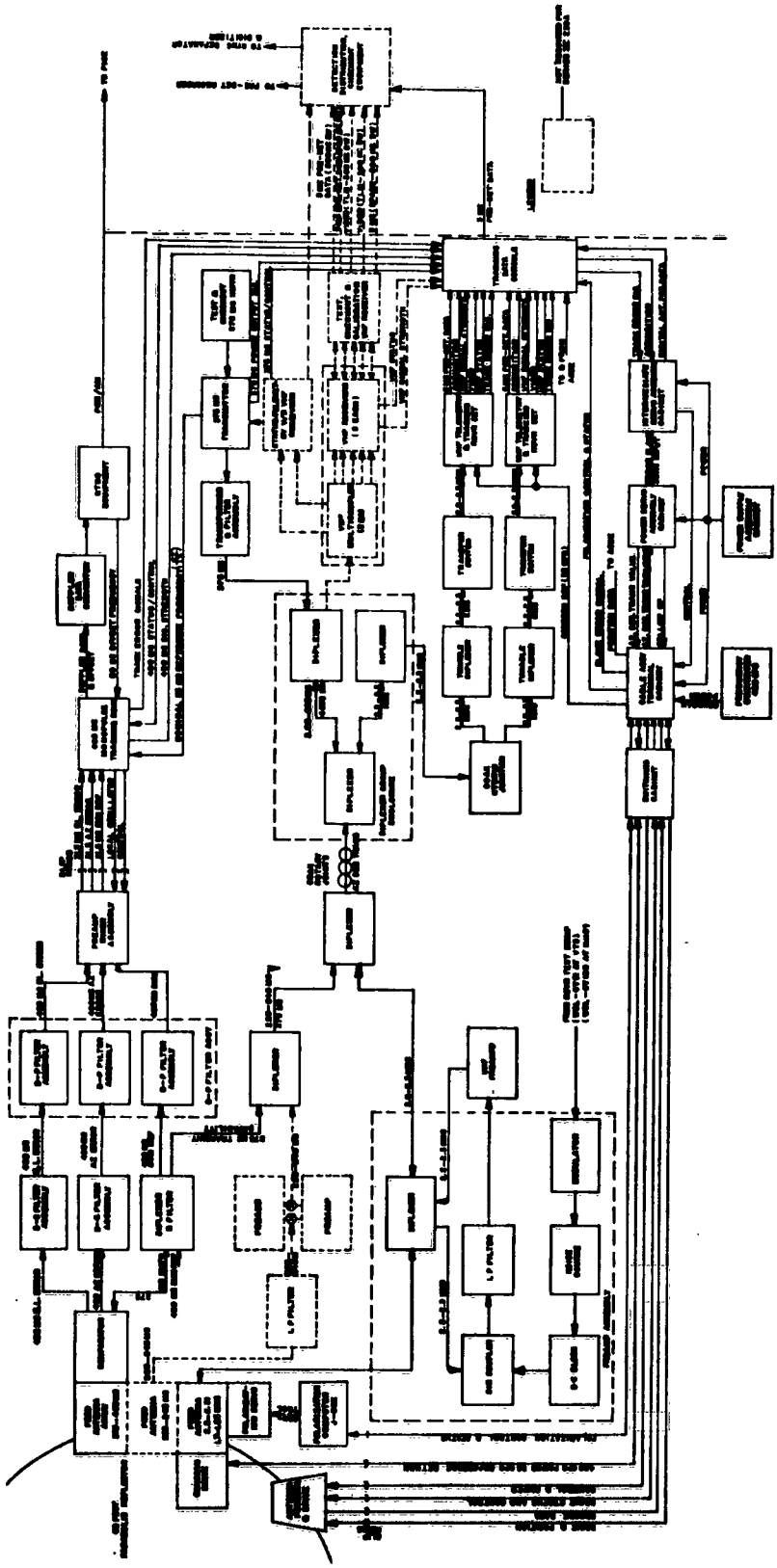


Fig. 4-1 Block Diagram of Multipurpose Antenna System

4.2 GENERAL DESCRIPTION OF CONSOLE

4.2.1 Console Configuration

The T&D console is made up of four bays in line (Figs. 4-2 and 4-3). It is intended to be operated by two people: the antenna controller at the left three bays, and the RF operator at the right bay. The console is located in the Data Receiver (D/R) buildings at VTS and NHS. The consoles are identical at both sites, except for the inclusion of a television boresight display and a wind speed indicator on the VTS console. At the time this report was written, a work order had not been issued for the RF panel; consequently, the information pertaining to it in this report is not to be regarded as final.

4.2.2 Console Functions

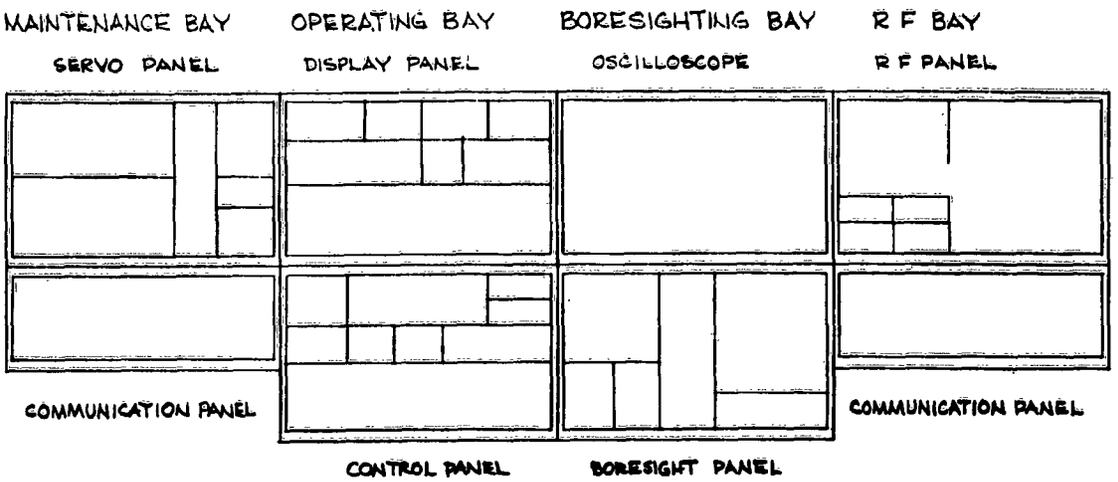
The console is designed to provide the operators with the capability of accomplishing large-loop equipment readiness checks and most of the required during-pass control and monitoring functions. The equipment, which is partially controlled and monitored to carry out these functions, includes the antenna system, boresight transmitters, Doppler system, UHF tracking receivers, and VHF receivers. Each of these equipment systems is described in the following section.

4.2.3 Console-Controlled Equipment

The following paragraphs describe the equipment associated with the T&D console. The five equipment areas are the antenna drive, boresight equipment, T&D receivers, Doppler system and VHF receivers.

Antenna Drive

The antenna drive system within the T&D building is composed of intermediate and power servos for each antenna axis. The positioning of the azimuth, transverse, and declination intermediate servos ultimately results in the antenna axes assuming the corresponding positions. The signal sources for the positioning of the intermediate servos are



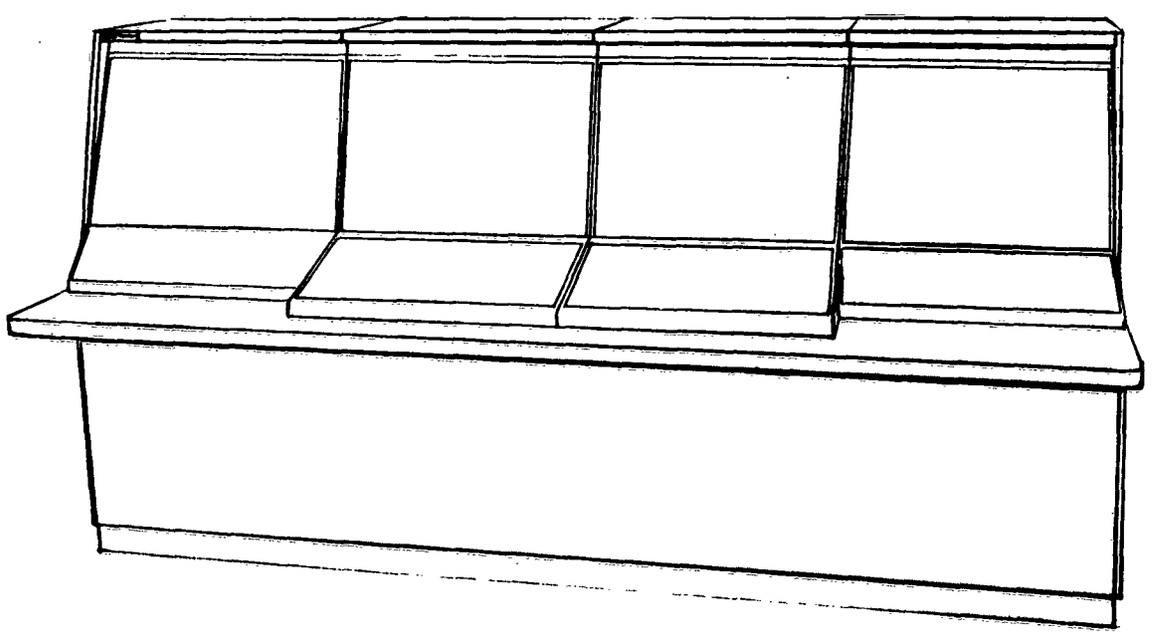


Fig. 4-7 Console Configuration

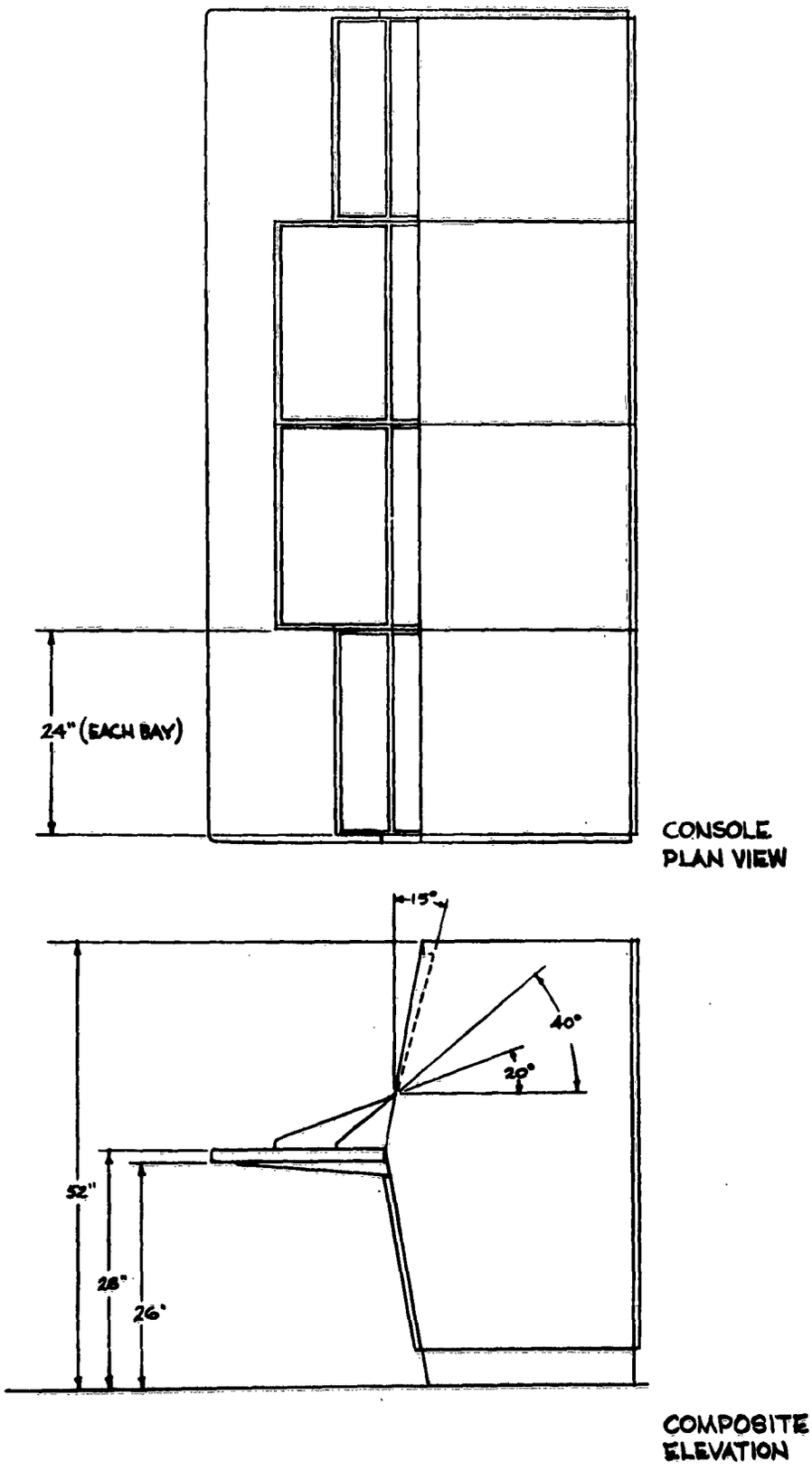


Fig. 4-3 Console Plan View and Composite Elevations

a. Console rate controls,

b. Remote rate controls,

c. Digital-to-analog converters (DACON's),

d. Search scan generator, and

e. Tracking receivers.

The console rate controls (Fig. 4-4) and the remote rate controls generate voltages proportional in amplitude to the sine of the displacement from their center null positions. These voltages are applied to the intermediate servos when the console is in the mode. Console information and status are provided on the display panel(Fig. 4-5).

The outputs of the DACON's are applied to the power servos when the antenna is in the SLAVED or BORESIGHT mode. The voltages are proportional in amplitude to the difference between the desired and actual antenna positions. The desired antenna position information is accepted from a remote source when the antenna is in the SLAVED mode and from the control panel in the ASDE rack when in the BORESIGHT mode. Servo error is displayed on the servo panel (Fig. 4-6).

When the antenna is in the SEARCH mode, the intermediate servos accept information from the search scan generator. The width rate and inclination of the bar scan are selected at the console.

When the antenna is in the AUTOTRACK mode, the selected tracking receiver supplies the error voltages to the intermediate servos. The tracking receiver is selected on the RF panel of the console (Fig. 4-7).

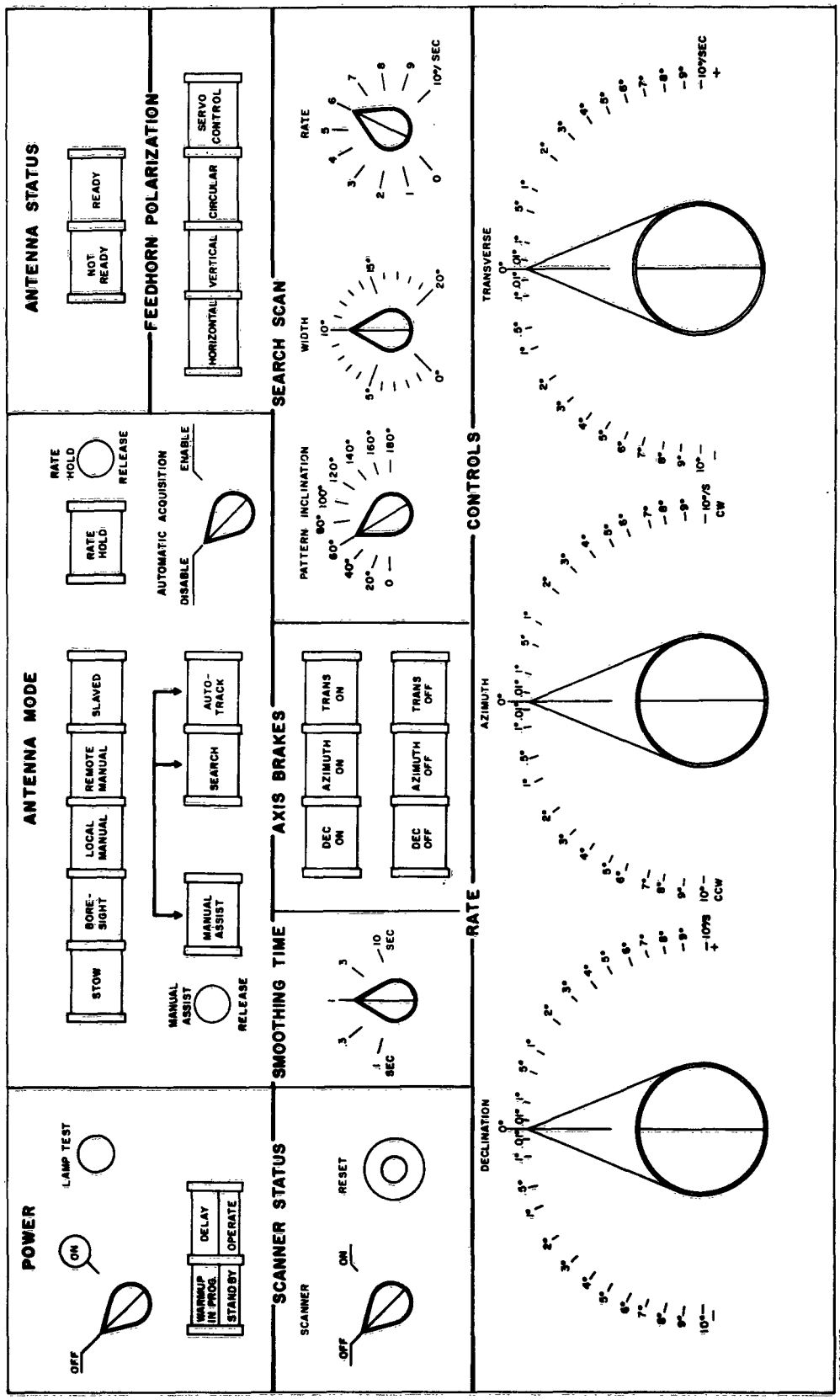


Fig. 4-4 Control Panel

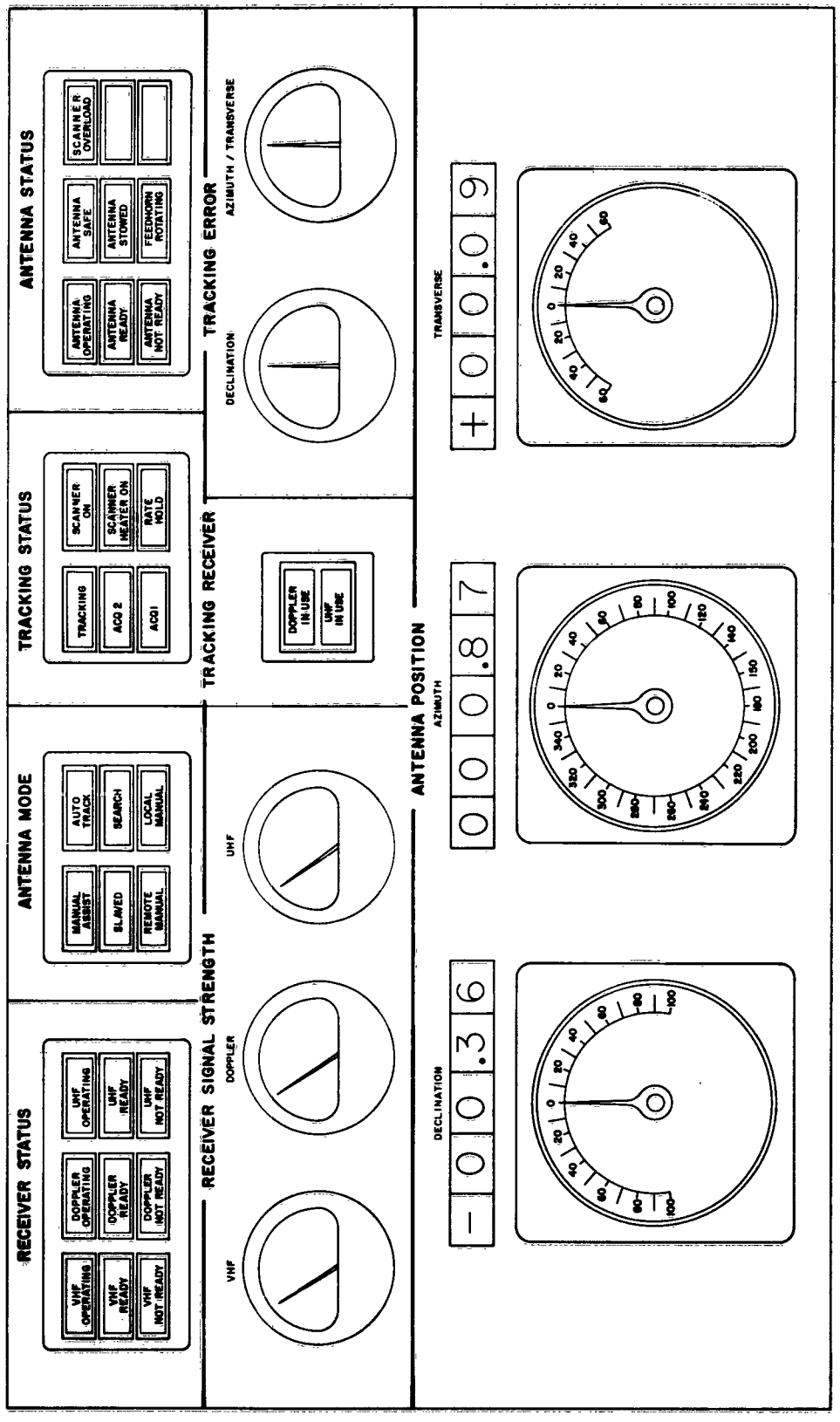


Fig. 4-5 Display Panel

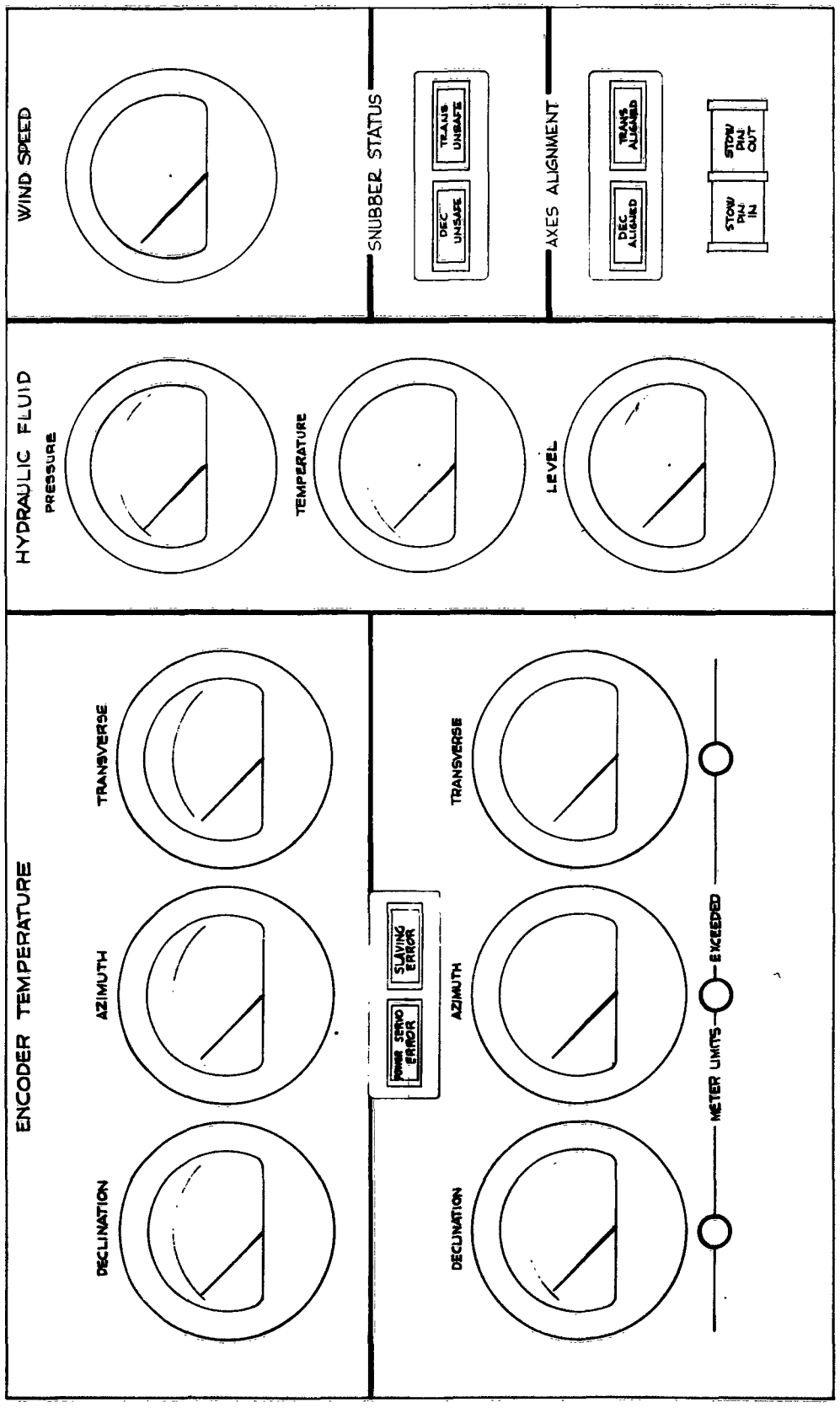


Fig. 4-6 Servo Panel

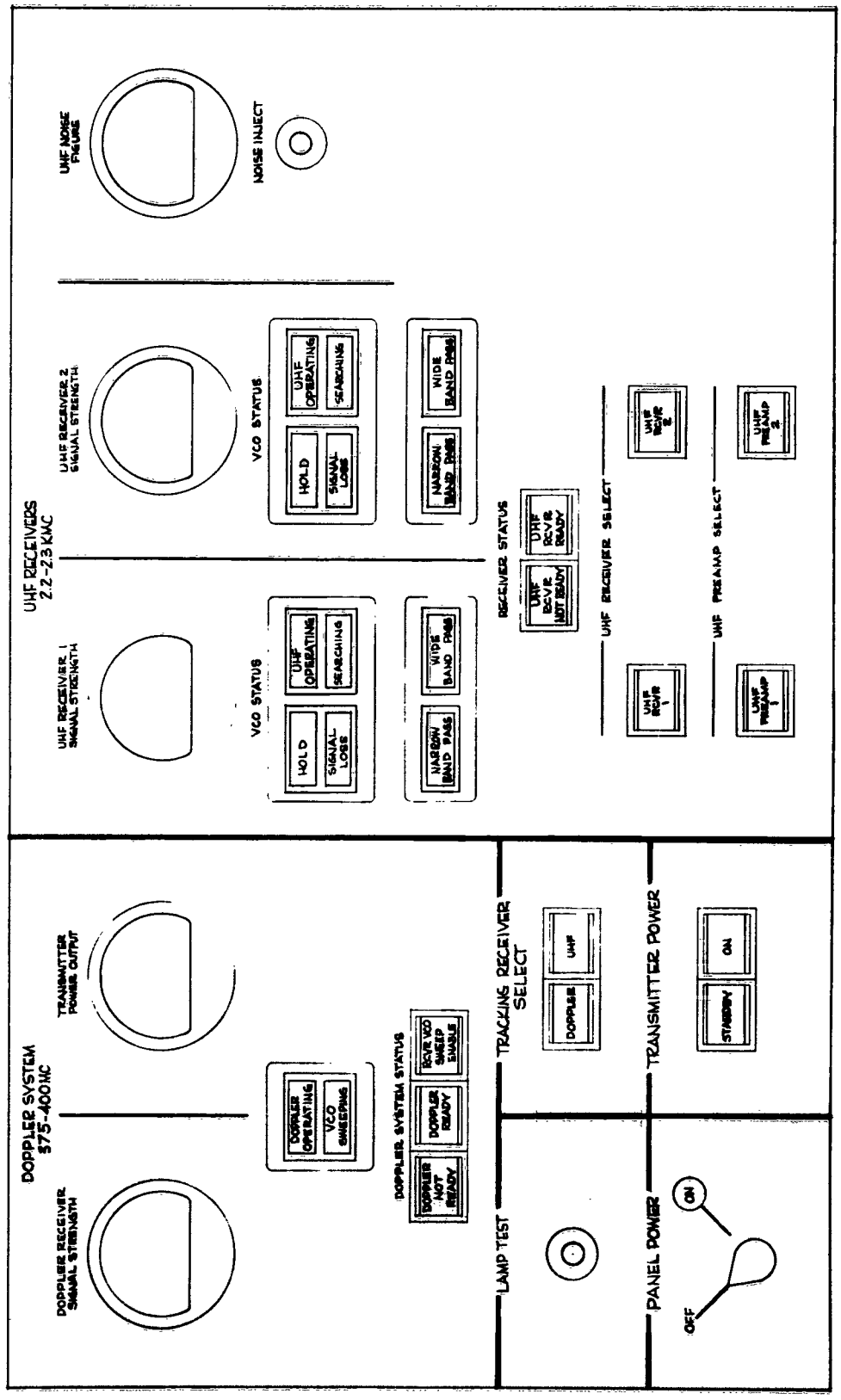


Fig. 4-7 RF Panel

At the time this report was written, two sets of servo equipment existed in the D/R building, one of which is required for the self-track capability. A switch in the cablehead rack selects the set of servo equipment to be enabled.

Boresight Equipment

The dial control on the Boresight panel (Figs. 4-8 and 4-9) provides the antenna operator with control of several transmitter functions in the near field and far field boresight towers. By dialing an appropriate number, control is provided for any of the boresight transmitters, with selection of various frequencies and attenuation levels. Also, control is provided to turn on the optical targets, the PAM simulator, and control of the T&D antenna-mounted boresight equipment.

When a number is dialed, a pulse train is routed to the Boresight Control Rack, OA-53. The pulse train is decoded at OA-53 and routed to its proper destination to accomplish the desired control action. The Near Field Rack, OA-118, or Far Field Rack No. 1, OA-55, receives the signal from the Boresight Control Rack and converts it to a control voltage. This voltage is applied to the proper equipment to accomplish the desired control action. A verification signal is sent back to the Boresight panel to emergize the legend light corresponding to the completed control action.

The outputs of the selected UHF receiver and the PAM simulator can be displayed on the two-gun oscilloscope in the boresight bay of the console. By displaying the output of the PAM simulator on one gun and the output of the UHF or VHF receiver on the other gun, the test signal can be compared before it is sent to the boresight transmitters and after it is received by the T&D antenna receiver.

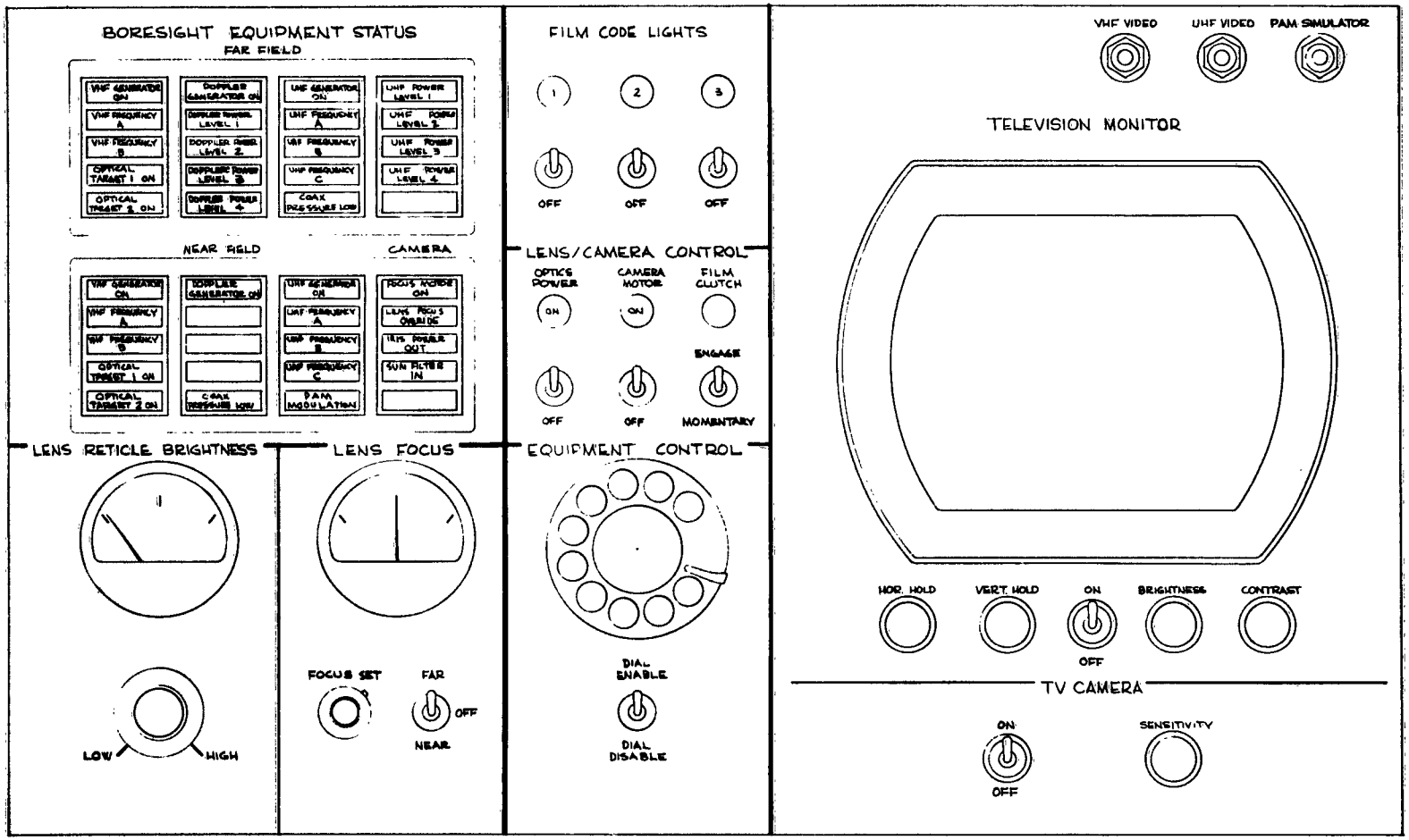


Fig. 4-8 VTS Boresight Panel

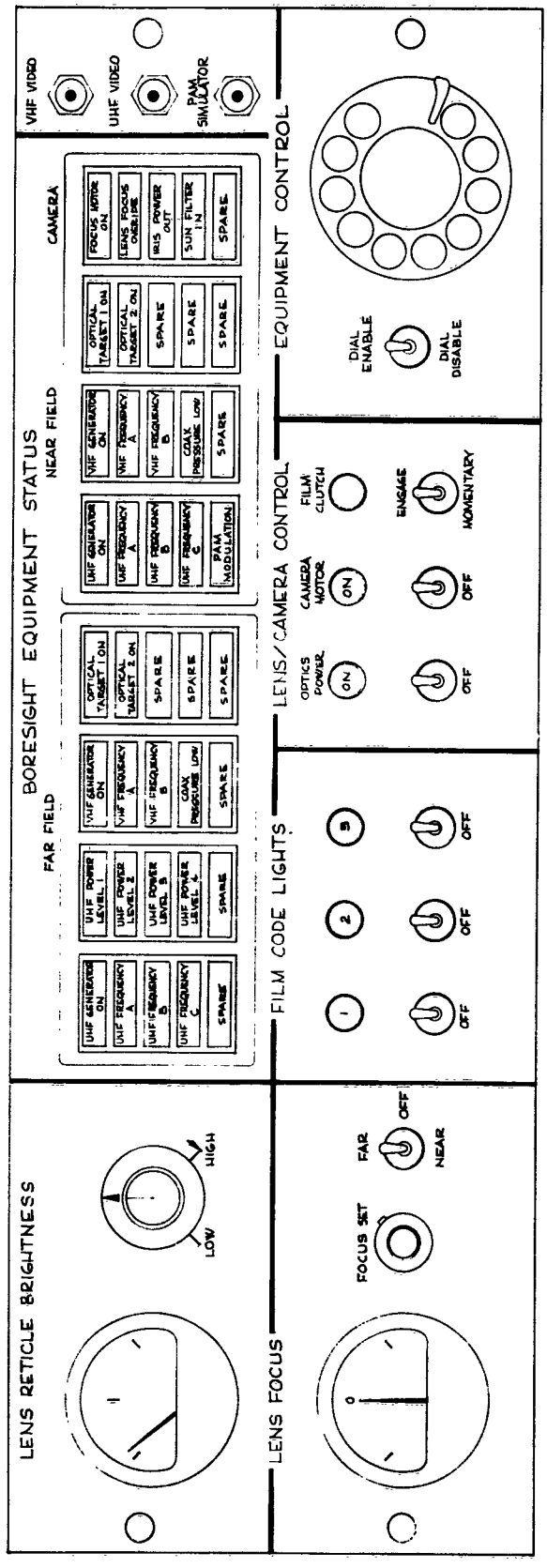


Fig. 4-9 NHS Boresight Panel

The antenna controller has sufficient controls and information displayed on the console to conduct confidence checks of both the antenna columniation and the quality of the received signal.

Tracking and Data Receiver

The two Tracking and Data (T&D) receivers recover the 2.2-2.3 Gc PAM data from the satellite. They will also supply tracking error voltages to the antenna servo system for the autotrack function when Revision 2 of the modification is implemented.

Figure 4-10 is a simplified block diagram of the T&D receivers. It shows that the incoming signal is amplified by preamp 1 or preamp 2 depending upon which is chosen by the T&D console operator. (See Fig. 4-11 for the tracking procedure.) The signal passes through a filter and is routed to both T&D receivers by a hybird coaxial junction. After the signal is converted to 5 Mc, it passes through the selectable bandpass filters and is then available for routing to the DAP building for processing and to the tracking converter for conversion to tracking error voltages. The receiver supplying the signal for these purposes is selected at the RF panel. The 5 Mc signal from both receivers is limited, detected, amplified, and displayed on a spectrum analyzer at the same time for comparison..

Figure 4-12 is a flow diagram showing the interaction between the voltage-controlled oscillator (VCO) statuses and the antenna modes for one receiver. The five VCO statuses are as follows:

Search - The VCO automatically sweeps the receiver tuning about a center frequency at a rate of approximately 10 cps.

Hold - If the receiver detects a signal between the -104 and -94 dbm levels, the VCO will leave the "search" status and enter the "hold" status. It will remain in the "hold" status for approximately

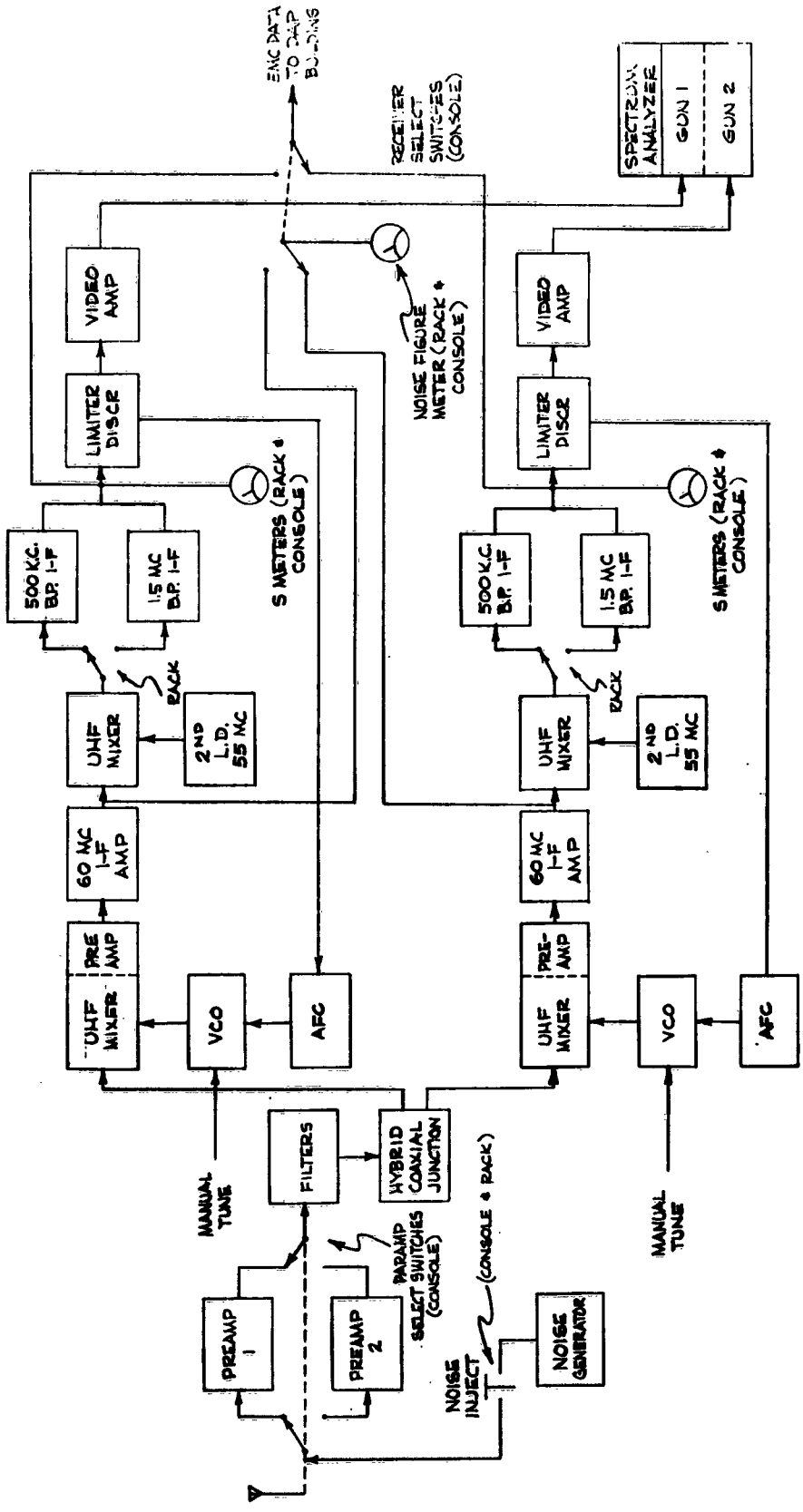


Fig. 4-10 Block Diagram of UF Receiver

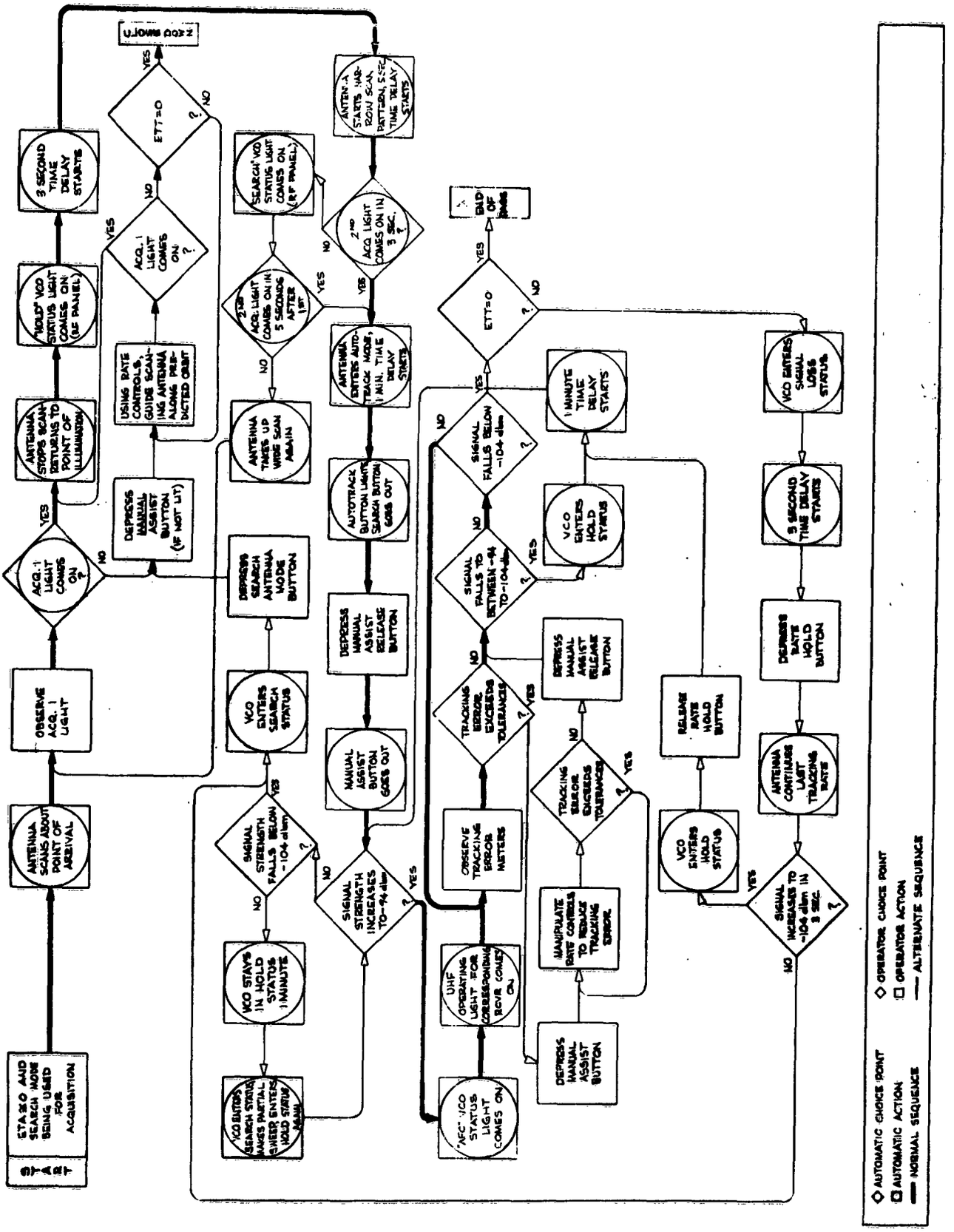


Fig. 4-11 UF Tracking

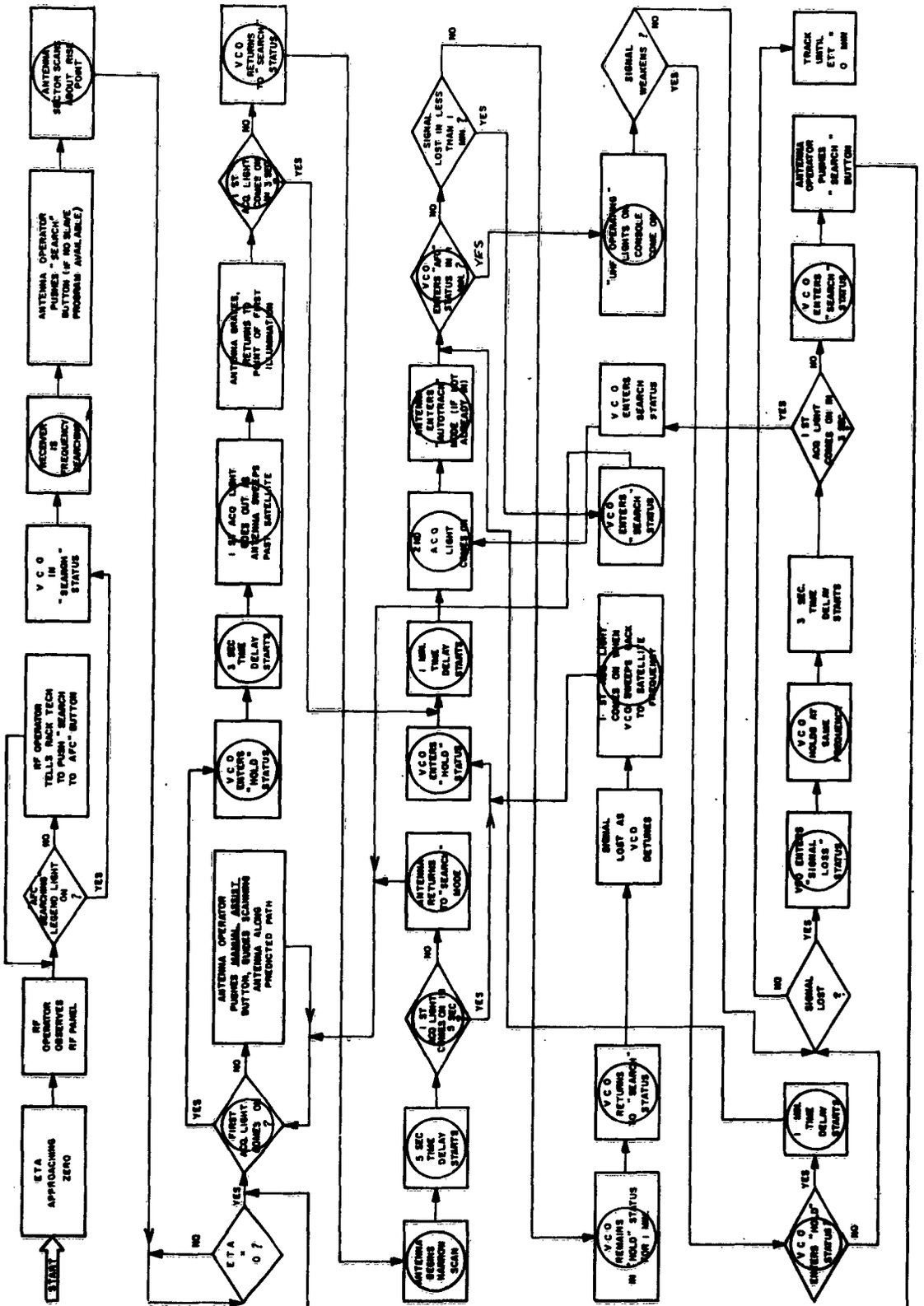


Fig. 4-12 Interaction between 2.2-2.3 Gc Tracking Receiver and Antenna Modes

3 seconds, even if the received signal is lost. If the signal persists, the VCO will remain in the "hold" status for approximately 1 minute. In this status, the VCO keeps the receiver tuned to the frequency at which the signal was first detected. At the end of 1 minute, the VCO will enter the "search" status, make partial sweep, and re-enter the "hold" status in less than 0.1 second. If the received signal falls below the -104 dbm level, the VCO will return to the "search" status. If the signal increases above the -94 dbm level, the VCO will enter the "AFC" status.

AFC - The received signal must be avove the -94 dbm level for the VCO to be in the "AFC" status. In this status, the VCO continually tunes the receiver to the frequency of the incoming signal. When either VCO is in the "AFC" status, the "UHF OPERATING" light corresponding to that receiver will be energized on the RF panel.

Manual - When the VCO is in the "manual" mode, it can be tuned manually.

Signal Loss - If the received signal falls below the -94 dbm level, the VCO will enter the "signal loss" status for 3 seconds, then enter the "search" status. In the "signal loss" status, the VCO remains tuned to the same frequency at which the signal was lost.

Doppler System

The main components of the Doppler system are the 375 Mc transmitter, the 400 Mc receiver, and the 4-element monopulse feedhorn. The transmitter is located in equipment rack OA-119 and the receiver in equipment rack OA-79.

The transmitter transmits a highly stable frequency to the satellite. The satellite accurately upconverts the frequency by a constant amount and transmits a return frequency to the ground station. The ground receiver detects the return frequency and extracts its rate

of change due to the Doppler shift. From the rate of change of the received frequency and the angular position of the antenna, the satellite ephemerides can be calculated. Besides extracting the Doppler data from the vehicle signal. The Doppler receiver provides tracking error voltages to the antenna intermediate servos for autotrack purposes.

The satellite signal is received through the hybird monopulse feedhorn, then divided between the azimuth, elevation, and reference channels of the receiver (Fig. 4-13). Each channel is identical up the 4.5 Mc i-f amplifiers. The VCO, which is tuned by the phase lock loop during signal tracking, provides the mixing frequency to the mixers to keep the input to the i-f amplifiers at exactly 4.5 Mc. The Doppler extractor takes its input from the VCO to provide range rate information. Figure 4-13 shows where the console control and display points were selected on the basis of their usefulness during a pass. Prepass operations, such as calibrating, peaking, etc., were functions to be performed by the rack technician. The console operation of the Doppler system is diagrammed in Fig. 4-14, and the layout of the console panel from which the Doppler system is controlled is shown in Fig. 4-7.

The primary tasks of the Doppler system operator are to

a. Ensure that the Doppler transmitter output is routed to the antenna feedhorn and is of proper strength,

b. Ensure that the VCO is frequency-searching before ETA reaches zero,

c. Select the proper tracking receiver (UHF or Doppler), and,

d. Restart the VCO sweep after a monentary signal loss during a pass.

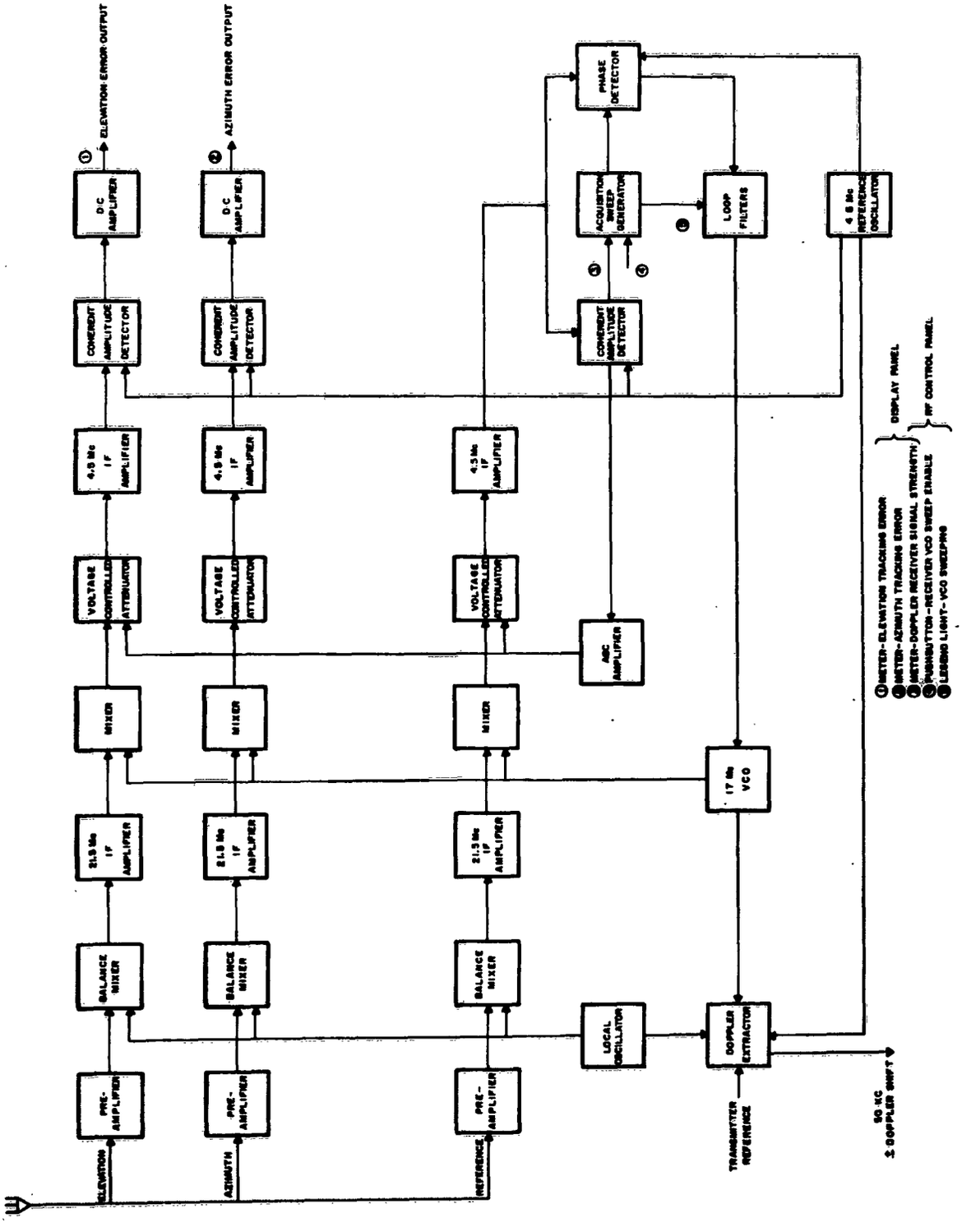


Fig. 4-13 Block Diagram of Doppler Equipment

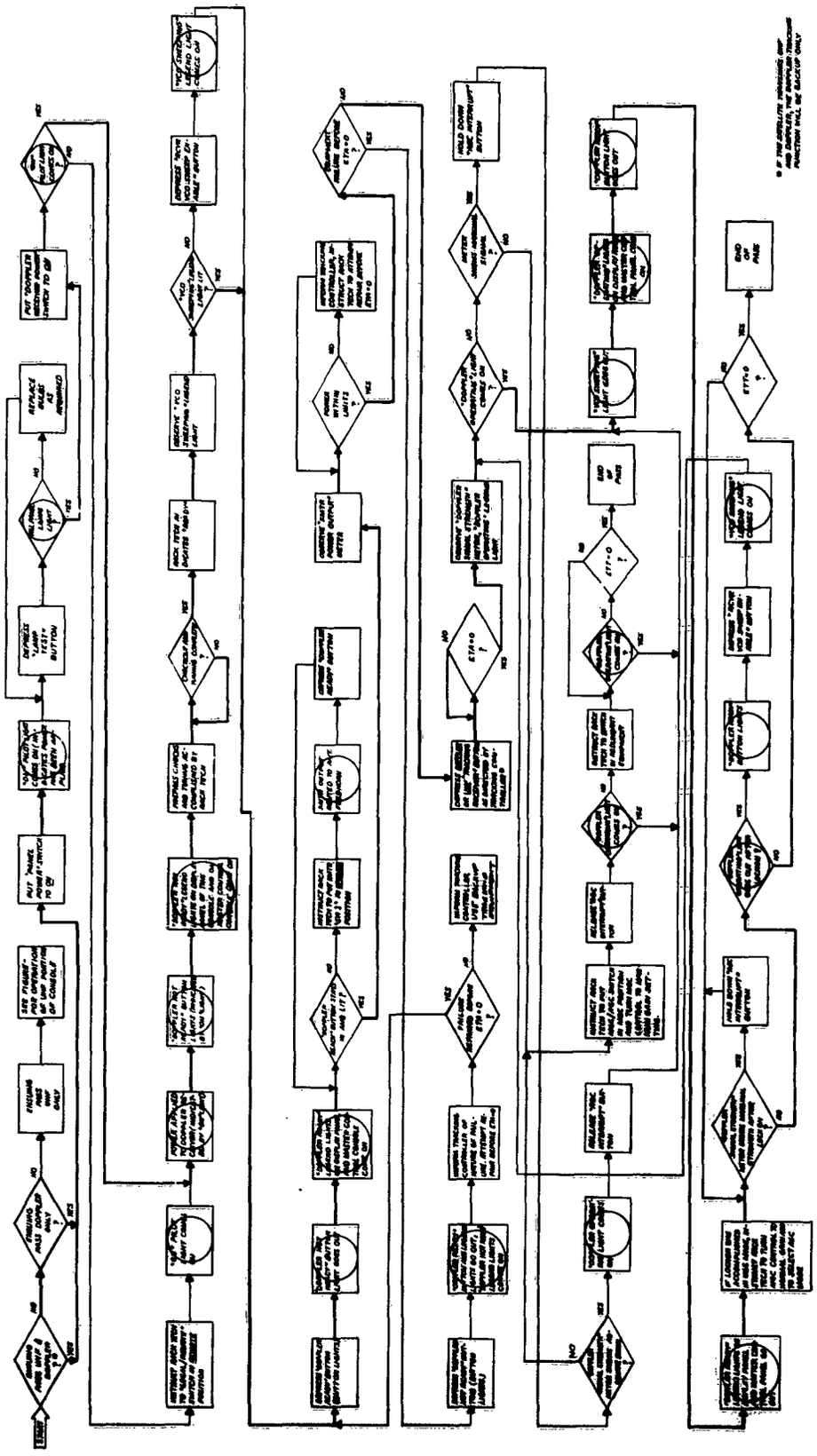


Fig. 4-14 Console Operation of Doppler Equipment

VHF Receivers

The console displays relating to the VHF receivers are the NOT READY, READY, and OPERATING status lights and the VHF signal strength meter. The console has no control over the VHF receivers. The signal source for both the status lights and the signal strength meter is a control panel in VHF receiver rack OA-78. The VHF rack technician will continually appraise the status (NOT READY, READY, or OPERATING) of each of the five receivers and will select a switch position on the control panel for the corresponding status. This will energize the appropriate status lights on both the T&D console and the master control console.

During a pass, the VHF signal strength meter on the T&D console is used as a manual tracking display. The antenna controller can keep the meter "peaked" by manipulating the rate controls in order to drive the antenna in the proper direction.

The choice of the VHF receiver to supply the meter on the console is made by the VHF rack technician. It is his task to select the best signal and to select a switch position on the control panel for the appropriate receiver. This will route the signal strength of the best receiver to the console.

4.3 DETAILED DESCRIPTION OF CONSOLE

4.3.1 Panel Hardware Function Lists

Each piece of panel hardware on the Left Bay-Servo Panel (Table 4-1), Center Bay-Display Panel (Table 4-2), Control Panel (Table 4-3), Boresight Panel-VTS (Table 4-4), and RF Panel (Table 4-5) is itemized on the following pages. The location, nomenclature, hardware, function, and signal source (if applicable) for each control and display on each panel are briefly described.

TABLE 4-1

LEFT BAY - SERVO PANEL

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Encoder Temperature Group Displays	DECLINATION	Meter	Indicates temperature of declination shaft encoder	Transducer in declination shaft encoder
	AZIMUTH	Meter	Indicates temperature of azimuth shaft encoder	Transducer in azimuth shaft encoder
	TRANSVERSE	Meter	Indicates temperature of transverse shaft encoder	Transducer in transverse shaft encoder
Error Group Displays	POWER SERVO ERROR	Light, legend, white lens	Indicates the axis error meters are displaying power servo error	Lit when antenna is in any mode but SLAVED or BORESIGHT
	SLAVING ERROR	Light, legend, white lens	Indicates the axis error meters are displaying slaving error	Lit when antenna is in SLAVED or BORESIGHT mode
	DECLINATION AZIMUTH TRANSVERSE	Meter Meter Meter	Indicates power servo error or slaving error for the respective axis depending upon which of the above two lights are lit	Power servo system or ASDE system

TABLE 4-1

LEFT BAY - SERVO PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Error Group Displays (Cont.)	METER LIMITS EXCEEDED			Card A 106 of ASDE Amplifier
	DECLINATION	Light, pilot, red	Indicates that respective meters have been removed from the circuit to prevent overloading	
	AZIMUTH	Light, pilot, red		
	TRANSVERSE	Light, pilot, red		
Hudraulic Fluid Group Displays	LEVEL	Meter	Indicates reservoir fluid level	Transducer in hydraulic reservoir
	TEMPERATURE	Meter	Indicates reservoir fluid temperature	Transducer in hydraulic reservoir
	PRESSURE	Meter	Indicates reservoir fluid pressure	Transducer in hydraulic reservoir
Wind Speed Indicator (VTS only)	WIND SPEED	Meter	Indicates wind speed	Wind sensor on building
Snubber Status Group Displays	DEC UNSAFE	Light, legend, red	Indicates snubber unsafe	Pressure transducer in snubber system
	TRANS UNSAFE	Light, legend, red	Indicates snubber unsafe	Pressure transducer in snubber system
Axis Alignment Group Displays	DEC ALIGNED	Light, legend, green	Indicates declination axis pointed at zenith	Microswitch in antenna
	TRANS ALIGNED	Light, legend, green	Indicates transverse axis is exactly at zero	Microswitch in antenna

TABLE 4-1

LEFT BAY - SERVO PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Controls	STOW PIN IN	Pushbutton switch, momentary, red legend	Energizes motor to drive stow pin into stow position	N/A
	STOW PIN OUT	Pushbutton switch, momentary, white legend	Energizes motor to drive stow pin out of stow position	N/A

TABLE 4-2

CENTER BAY - DISPLAY PANEL

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Receiver Status Group Display	VHF OPERATING	Light, legend, green	Indicates that the VHF receivers are receiving signals of satisfactory strength	Manually selected switch position at VHF receiver rack
	VHF READY	Light, legend, yellow	Indicates that the VHF receivers are ready for operation (checked out)	Manually selected switch position at VHF receiver rack
	VHF NOT READY	Light, legend, red	Indicates that the VHF receivers are not ready for operation	Manually selected switch position at VHF receiver rack
	DOPPLER OPERATING	Light, legend, green	Indicates that the doppler receiver has "locked" onto the satellite signal	"Lock-on" signal from doppler receiver
	DOPPLER READY	Light, legend yellow	Indicates that the doppler system is ready for operation (checked out)	Manually selected switch position on RF panel of console
	DOPPLER NOT READY	Light, legend, red	Indicates that the doppler system is not ready for operation	Manually selected switch position on RF panel of console

TABLE 4-2

CENTER BAY - DISPLAY PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Receiver Status Group Display (Cont.)	UHF OPERATING	Light, legend, green	Indicates that the UHF receiver is receiving a signal of sufficient strength and that the AFC is in the AFC status	AFC status signal from either UHF receiver
	UHF READY	Light, legend, yellow	Indicates that the UHF receiver system is ready for operation (checked out)	Manually selected switch position on RF panel of console
	UHF NOT READY	Light, legend, red	Indicates that the UHF receiver system is not ready for operation	Manually selected switch position on RF panel of console
Antenna Mode Group Displays	MANUAL ASSIST	Light, legend, white	Indicates that the MANUAL ASSIST antenna mode selection switch has been depressed. The RATE CONTROLS are enabled for use in conjunction with the SEARCH OR AUTO-TRACK modes.	MANUAL ASSIST switch in the Antenna Mode group

TABLE 4-2

CENTER BAY - DISPLAY PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Antenna Mode Group Displays (Cont)	SLAVED	Light, legend, green	Indicates that the SLAVED Antenna Mode selection switch has been depressed. The antenna will follow positioning information from a remote source	SLAVED switch in the Antenna Mode group
	REMOTE MANUAL	Light, legend, white	Indicates that the RATE CONTROLS are disabled and that antenna control has been relinquished to a remote source	REMOTE MANUAL switch in the Antenna Mode group
	AUTO TRACK	Light, legend, green	Indicates that the antenna is automatically tracking a satellite signal	AUTOTRACK switch in the Antenna Mode group
	SEARCH	Light, legend, white	Indicates that the antenna will scan according to the parameter set in with the SEARCH SCAN controls	SEARCH switch in the Antenna Mode group
	LOCAL MANUAL	Light, legend, white	Indicates that the RATE CONTROLS are enabled for local control of the antenna	LOCAL MANUAL switch in the Antenna Mode group

TABLE 4-2

CENTER BAY - DISPLAY PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Tracking Status Group Displays	TRACKING	Light, legend, green	Indicates that either the doppler or 2.3 kmc receiver error signals are driving the antenna, depending upon which TRACKING RECEIVER light (this panel) is lit	Lock-on signal from tracking receiver
	ACQ 2	Light, legend, white	Indicates that the second phase of the automatic acquisition sequence is in progress	Threshold detector of tracking receiver signal strength
	ACQ 1	Light, legend, white	Indicates that the first phase of the automatic acquisition sequence is in progress	Tracking receiver
	SCANNER ON	Light, legend, green	Indicates that the conical scan motor has been energized	SCANNER ON-OFF switch in the Scanner Status group (control panel)
	SCANNER HEATER ON	Light, legend, green	Indicates that power has been applied to the heater for the conical scan mechanism	Heater current control relay
	RATE HOLD	Light, legend, yellow	Indicates that the antenna is being driven by the rate memory circuitry	RATE HOLD switch in the Antenna Mode group

TABLE 4-2

CENTER BAY - DISPLAY PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Antenna Status Group Displays	ANTENNA OPERATING	Light, legend, green	Indicates that the OPERATE power light is on, an Antenna Mode has been selected, and that a response has been obtained from the power servos	Power servos
	ANTENNA READY	Light, legend, yellow	Indicates that the antenna operator has established that the antenna system is ready and depressed the READY Antenna Status switch (control panel)	READY switch in the Antenna Status group
	ANTENNA NOT READY	Light, legend, red	Indicates that console power has been applied but the READY Antenna Status switch has not been depressed	NOT READY Antenna Status switch in conjunction with the panel power switch
	ANTENNA SAFE	Light, legend, red	Indicates that the antenna cannot be moved by the console control	Switch in antenna pedestal
	ANTENNA STOWED	Light, legend, white	Indicates that the antenna is stowed and that all axes brakes are locked	STOW switch in Antenna Mode group

TABLE 4-2

CENTER BAY - DISPLAY PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Antenna Status Group Display	FEEDHORN ROTATING	Light, legend, white	Indicates that the polarization plane of the feedhorn is rotating	Microswitches in feedhorn assembly
	CONSOLE INOPERATIVE	Light, legend, red	Indicates that the console is not in the antenna drive state	Switch position on cablegead rack
	SCANNER OVERLOAD	Light, legend, red	Indicates overload condition of scanner motor drive	Circuit Breaker
Receiver Signal Strength Group Display	VHF	Meter	Indicates signal strength of the VHF receiver selected by the VHF rack technician	Selected VHF receiver
	DOPPLER	Meter	Indicates signal strength of doppler receiver	Doppler receiver
	UHF	Meter	Indicates signal of UHF receiver selected by RF panel operator	Selected 212 kmc receiver
Tracking Receiver Group Display	DOPPLER IN USE	Light, legend, white	Indicates that the DOPPLER Tracking Receiver selection switch has been depressed (RF panel)	DOPPLER Tracking Receiver selection switch

TABLE 4-2

CENTER BAY - DISPLAY PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Tracking Receiver Group Display (Cont.)	UHF IN USE	Light, legend, white	Indicates that the UHF Tracking receiver selection switch has been depressed (RF panel)	UHF Tracking Receiver selection switch
Tracking Error Group Display	DECLINATION	Meter (null)	Indicates the tracking error of the declination axis (desired position actual position)	Tracking receiver (Doppler or selected UHF receiver)
	AZIMUTH/TRANSVERSE	Meter (null)	Indicates the tracking error of the azimuth a transverse axis, whichever is active (desired position actual position)	Tracking receiver (Doppler or selected UHF receiver)
Antenna Position Group Display	DECLINATION	Decimal readout and dial	Indicates the position of the declination intermediate servo	Decimal readout from grey to decimal translator, dial indication from synchro resolvers
	AZIMUTH	Decimal readout and dial	Indicates the position of the declination intermediate servo	Decimal readout from grey to decimal tranlator, dial indication from synchro resolvers

TABLE 4-2

CENTER BAY - DISPLAY PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Antenna Position Group Display (Cont.)	TRANSVERSE	Decimal readout and dial	Indicates the position of the declination intermediate servo	Decimal readout from grey to decimal translator, dial indication from synchro resolvers

TABLE 4-3

CONTROL PANEL

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Power Group Controls	OFF-ON	Switch, knob, pointer	Applies power to the antenna equipment	N/A
	WARMUP IN PROGRESS/ STANDBY	Switch, pushbutton, illuminated, amber	When depressed, WARMUP IN PROGRESS half light. When warmup complete, WARMUP IN PROGRESS light goes out, STANDBY light comes on, DELAY/OPERATE button is enabled	Relay logic lights illuminated pushbutton
	DELAY/OPERATE	Switch, pushbutton, illuminated, yellow	When depressed, DELAY half lights, WARMUP IN PROGRESS/STANDBY button is released. After 30^{+6} second delay, DELAY light goes out, OPERATE light and OPERATING Antenna Status light comes on	Relay logic lights illuminated pushbutton
	LAMP TEST	Switch, pushbutton momentary	When depressed, lights all console lamps.	N/A
Displays	ON	Light, pilot, green	Indicates power has been applied to the console and antenna servo system	Power relay

TABLE 4-3

CONTROL PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Antenna Mode Group Controls	STOW	Switch, Pushbutton, illuminated, white, solenoid-held	Stows antenna.	N/A
	BORESIGHT	Switch, pushbutton, illuminated, white	Puts ASDE equipment in Enable Test Active mode	N/A
	LOCAL MANUAL	Switch, pushbutton, illuminated, white, solenoid-held	Enable for RATE CONTROLS for control of the antenna	N/A
	REMOTE MANUAL	Switch, pushbutton, illuminated, white, solenoid-held	Disable the RATE CONTROLS and enables the remote control of the antenna	N/A
	SLAVED	Switch, pushbutton, illuminated, green, solenoid-held	Permits antenna to follow remotely generated positioning information	N/A
	RATE HOLD	Switch, illuminated, amber, solenoid-held	Causes the antenna to continue its track at the same rate as immediately before the button was depressed	N/A
	RELEASE RATE HOLD	Switch, pushbutton, momentary	Releases depressed RATE HOLD button	N/A

TABLE 4-3

CONTROL PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Antenna Mode Group Controls	MANUAL ASSIST RELEASE	Switch, pushbutton, momentary	Releases depressed MANUAL ASSIST button	N/A
	SEARCH	Switch, pushbutton, illuminated, white, solenoid-held	Causes the antenna to sca according to the parameters set in with the SEARCH SCAN controls	N/A
	MANUAL ASSIST	Switch, pushbutton, illuminated, white, solenoid-held	Enables the RATE CONTROLS when the antenna is in the SEARCH of AUTOTRACK mode	N/A
	AUTOTRACK	Switch, pushbutton, illuminated, white, solenoid-held	Causes the antenna to follow either the doppler or 2.3 kmc receiver error signals, depending upon which Tracking Receiver selection button (RF panel) is depressed	N/A
	AUTOMATIC ACQUISITION ENABLE/DISABLE	Switch, knob, pointer, rotary	Enables the automatic tracking and acquisition circuitry	N/A

TABLE 4-3

CONTROL PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Antenna Status Group Controls	NOT READY	Switch, pushbutton, illuminated, red, solenoid-held	Indicates to the Tracking Controller that the antenna is energized but not ready for operation	Button lights when console power is first applied, goes out when READY button is depressed, lights again if NOT READY button is depressed
	READY	Switch, pushbutton, illuminated, yellow, solenoid-held	Indicates to the Tracking Controller that the antenna is ready for operation	Button lights when depressed
Feedhorn Polarization Group	HORIZONTAL	Switch, pushbutton, illuminated, solenoid-held, white	Causes the antenna feedhorn to be polarized horizontally	N/A
	VERTICAL	Switch, pushbutton, illuminated, solenoid-held, white	Causes the antenna feedhorn to be polarized vertically	N/A
	CIRCULAR	Switch, pushbutton, illuminated, solenoid-held, white	Causes the antenna feedhorn to be polarized circularly	N/A
	SERVO CONTROL	Switch, pushbutton, illuminated, solenoid-held, green	Causes the feedhorn polarization to be controlled by the servo system	N/A
Scanner Status Group Controls	OFF/ON	Knob, pointer, rotary switch	Applies power to scanner motor	N/A

TABLE 4-3

CONTROL PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Scanner Status Group Controls	RESET	Pushbutton, momentary	Resets scanner overload interlock	N/A
Smoothing Time	.1 - 10 seconds	Knob, pointer, rotary switch	Selects desired servo smoothing time	N/A
Axes Brakes	DEC ON	Switch, pushbutton, illuminated, red	Applies brakes to declination axis	N/A
	AZIMUTH ON	Switch, pushbutton, illuminated, red	Applies brakes to azimuth axis	N/A
	TRANS ON	Switch, pushbutton, illuminated, red	Applies brakes to transverse axis	N/A
	DEC OFF	Switch, pushbutton, illuminated, green	Releases declination axis brake	N/A
	AZIMUTH OFF	Switch, pushbutton, illuminated, green	Releases azimuth axis brake	N/A
	TRANSVERSE OFF	Switch, pushbutton, illuminated, green	Releases transverse axis brake	N/A
Search Scan Group	Pattern Inclination, 0-180 degrees	Knob, pointer, rotary switch	Adjusts the angle of the bar scan with respect to the horizon	N/A
	WIDTH 0 to 20 degrees	Knob, pointer, rotary switch	Adjusts the width of the bar scan	N/A

TABLE 4-3

CONTROL PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Search Scan Group (continued)	RATE 0 to 10 degrees per second	Knob, pointer, rotary switch	Adjusts the rate of scan	N/A
Rate Controls Group	DECLINATION -10 to +10 degrees per second	Knob, pointer, rotary switch	When the MANUAL Antenna Mode button is depressed, each Rate Control will adjust the rate with which the antenna rotates about the corresponding axis. These controls are also enabled if the MANUAL ASSIST Antenna Mode button is depressed when the antenna is in the SEARCH or AUTO-TRACK mode	N/A

TABLE 4-4

BORESIGHT PANEL, VTS

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Farfield Boresight Equipment Status Group Displays	UHF GENERATOR ON	Light, legend, white	Indicates UHF generator in farfield tower is on	Boresight equipment logic box
	UHF FREQUENCY A	Light, legend, white	Indicates which of 3 frequencies has been selected	Boresight equipment logic box
	UHF FREQUENCY B	Light, legend, white	Indicates which of 3 frequencies has been selected	Boresight equipment logic box
	UHF FREQUENCY C	Light, legend, white	Indicates which of 3 frequencies has been selected	Boresight equipment logic box
	COAX PRESSURE LOW	Light, legend, yellow	Indicates that coax pressure is below desired level	Boresight equipment logic box
	UHF POWER LEVEL 1	Light, legend, white	Indicates power level selected	Boresight equipment logic box
	UHF POWER LEVEL 2	Light, legend, white	Indicates power level selected	Boresight equipment logic box
	UHF POWER LEVEL 3	Light, legend, white	Indicates power level selected	Boresight equipment logic box
	UHF POWER LEVEL 4	Light, legend, white	Indicates power level selected	Boresight equipment logic box

TABLE 4-4

BORESIGHT PANEL, VTS (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Farfield Boresight Equipment Status Group (Cont.)	VHF GENERATOR ON	Light, legend, white	Indicates VHF generator in farfield tower is on	Boresight equipment logic box
	VHF FREQUENCY A	Light, legend, white	Indicates which of 2 VHF frequencies has been selected	Boresight equipment logic box
	VHF FREQUENCY B	Light, legend, white	Indicates which of 2 VHF frequencies has been selected	Boresight equipment logic box
	DOP GENERATOR ON	Light, legend, white	Indicates doppler generator in farfield tower is on	Boresight equipment logic box
	DOP POWER LEVEL 1	Light, legend, white	Indicates which of 4 doppler power levels has been selected	Boresight equipment logic box
	DOP POWER LEVEL 2	Light, legend, white	Indicates which of 4 doppler power levels has been selected	Boresight equipment logic box
	DOP POWER LEVEL 3	Light, legend, white	Indicates which of 4 doppler power levels has been selected	Boresight equipment logic box
	DOP POWER LEVEL 4	Light, legend, white	Indicates which of 4 doppler power levels has been selected	Boresight equipment logic box

TABLE 4-4

BORESIGHT PANEL, VTS (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Farfield Boresight Equipment Status Group Displays (Cont.)	OPTICAL TARGET 1 ON	Light, legend, white	Indicates that optical target 1 is illuminated	Boresight equipment logic box
	OPTICAL TARGET 2 ON	Light, legend, white	Indicates that optical target 2 is illuminated	Boresight equipment logic box
Nearfield Boresight Equipment Status Group	UHF GENERATOR ON	Light, legend, white	Indicates that the UHF generator in the near-field tower is on	Boresight equipment logic box
	UHF FREQUENCY A	Light, legend, white	Indicates which of 3 frequencies has been selected	Boresight equipment logic box
	UHF FREQUENCY B	Light, legend, white	Indicates which of 3 frequencies has been selected	Boresight equipment logic box
	UHF FREQUENCY C	Light, legend, white	Indicates which of 3 frequencies has been selected	Boresight equipment logic box
	PAM MODULATION	Light, legend, white	Indicates that PAM modulation has been turned on	Boresight equipment logic box
	VHF GENERATOR ON	Light, legend, white	Indicates that the VHF generator in the near-field tower is on	Boresight equipment logic box

TABLE 4-4

BORESIGHT PANEL, VTS (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Nearfield Boresight Equipment Status Group (Cont.)	VHF FREQUENCY A	Light, legend, white	Indicates which of 2 VHF frequencies has been selected	Boresight equipment logic box
	VHF FREQUENCY B	Light, legend, white	Indicates which of 2 VHF frequencies has been selected	Boresight equipment logic box
	COAX PRESSURE LOW	Light, legend, white	Indicates that the coax pressure is below the desired level	Boresight equipment logic box
	DOPPLER GENERATOR ON	Light, legend, white	Indicates that the doppler generator in the near-field tower is on	Boresight equipment logic box
	OPTICAL TARGET 1 ON	Light, legend, white	Indicates that optical target 1 is illuminated	Boresight equipment logic box
	OPTICAL TARGET 2 ON	Light, legend, white	Indicates that optical target 2 is illuminated	Boresight equipment logic box
Camera Group Displays	FOCUS MOTOR ON	Light, legend, white	Indicates that the motor which focuses the boresight telescope is running	Micro-switch in lens assembly

TABLE 4-4

BORESIGHT PANEL, VTS (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Camera Group Displays	LENS FOCUS OVER-RIDE	Light, legend, white	Indicates to console operator that console focus control is at the lens assembly	Manual switch in the lens assembly
	IRIS POWER OUT	Light, legend, white	Indicates no power to the camera aperature adjusting mechanism	Micro-switch in the lens assembly
	SUN FILTER IN	Light, legend, white	Indicates that the sun filter is in use	Micro-switch in the lens assembly
	LENS RETICLE BRIGHTNESS	Meter, Continuous scale	Indicates brightness of lens reticle	Lens reticle illumination circuit
	LENS FOCUS	Meter, null	Enables lens focusing at console	Bridge circuit
Controls	(Lens reticle) LOW-HIGH	Knob, round, rotary switch	Controls reticle brightness	N/A
	FOCUS SET	10-turn potentimeter	Deflects lens Focus Meter which will be nulled by FAR/OFF/NEAR	N/A
	FAR/OFF/NEAR	3-position toggle switch spring loaded to center "OFF" position	Energizes focusing motor	N/A
Film Code Light Group	1, 2, and 3	Lights, pilot, white	Indicates code used for coding film	Film code switches located below lights

TABLE 4-4

BORESIGHT PANEL, VTS (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Lens/Camera Control Group	OPTICS POWER ON	Light, pilot, white	Indicates that optics power has been applied	Optics power switch located below light
	CAMERA MOTOR ON	Light, pilot, white	Indicates that camera motor has been turned on	Camera motor switch located below light
	FILM CLUTCH	Light, pilot, white	Indicates that the film clutch has been engaged	ENGAGE/OFF/MOMENTARY switch below light
Equipment Control Group	DIAL ENABLE/DIAL DISABLE	2-position toggle switch	Enables or disables associated dial control	N/A
	EQUIPMENT CONTROL	Dial	Controls boresight tower transmitters, optical target, antenna mounted boresight equipment, and PAM simulator	N/A
TV Group	TV CAMERA	TV screen and associated controls	Displays image of boresight telescope	TV camera mounted behind boresight telescope

TABLE 4-5

RF PANEL

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Doppler Receiver Signal Strength Group Displays	DOPPLER RECEIVER SIGNAL STRENGTH	Meter, continuous scale. Green scale above lock-on strength. Yellow below it	Indicates Received Signal Strength	Output of Coherent Amplitude Detector (Lock Signal)
Controls	AGC INTERRUPT	Switch, pushbutton, momentary	Removes AGC from circuit (Shorts VCA Control Voltage to Ground	N/A
Transmitter Power Output Group Displays	TRANSMITTER POWER OUTPUT	Meter, continuous scale. Green scale indicates satisfactory power output	Indicates Power Output of 375 MC Transmitter	Parallels Existing Meter on Transmitter Panel
Doppler System Status Group Displays	DOPPLER OPERATING	Light, legend, green. When this light comes on, button light 3B2 (DOPPLER READY) goes out, but button stays in	Indicates that the Doppler Receiver has locked-on in frequency to a signal and is operating satisfactorily	Parallels "Lock" Indicator on Receiver Panel
Controls	DOPPLER NOT READY	Switch, pushbutton, illuminated, solenoid-held, red*, released when Control 3B2 (Doppler Ready) is depressed	Lights NOT READY legend lights on MCC and Display Panel of T&D Console	Lights when Doppler System is first energized, or when button is depressed

* All illuminated indicators will show color only when energized. When de-energized the background will be white.

TABLE 4-5

RF PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Controls	DOPPLER READY	Switch, pushbutton, illuminated, solenoid-held yellow*. Light goes out when Display 3A1, (Doppler Operating) comes on; released when Control 3B1 (Doppler Not Ready) is depressed; Interlocked with OPERATE position of Transmitter Switch S1, and (Power ON indicators)	Lights DOPPLER READY Legend Lights on MCC and Display Panel of T&D Console	Lights when depressed if Interlock conditions are satisfied
Tracking Receiver Group Controls	DOPPLER	Switch, pushbutton, illuminated, solenoid-held, white*, released when Control 4A2 (UHF) is depressed	Routes Error Signals from Doppler Receiver to Antenna Servos. Lights DOPPLER IN USE Light on Center Panel of the T&D Console	N/A
Controls	UHF	Switch, pushbutton, illuminated, solenoid-held, white*, released when Control 4A1 (DOPPLER) is depressed	Routes Error Signals from 2.2-2.3 kmc receivers to antenna servos. Lights UHF IN USE Light on Center Panel of the T&D Console	N/A

* All illuminated indicators will show color only when energized. When de-energized the background will be white.

TABLE 4-5

RF PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Receiver VCO Sweep Enable Control	VCO SWEEPING	Pushbutton, momentary, white*, goes out when Display 3A1 (DOPPLER OPERATING) comes on	Causes Receiver VCO to sweep around center frequency	Doppler Receiver Relay K2 (Acquisition Relay)
Doppler Receiver Power Group Display	ON	Light, pilot, green*	Indicates power has been applied to Doppler Receiver	Doppler Receiver
Control	OFF-ON	Knob, pointer, rotary switch	Energizes Doppler Receiver if Local/Remote Switch on Doppler Rack is in REMOTE position	N/A
Transmitter Power Group Display	ON	Light, pilot, green*	Indicates power has been applied to the Doppler Transmitter	Doppler Transmitter
Control	OFF-ON	Knob, pointer, rotary switch	Energizes Doppler Transmitter if Local/Remote Switch on Doppler Transmitter Panel is in REMOTE position	N/A
Panel Power Group Display	ON	Light, pilot, green*	Indicates panel power has been applied	Panel power relay
Control	OFF-ON	Knob, pointer, rotary switch	Energizes RF panel	N/A
Lamp Test Button	LAMP TEST	Switch, pushbutton, momentary	Lights all panel lamps	N/A

* All illuminated indicators will show color only when energized. When de-energized the background will be white.

TABLE 4-5

RF PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
UHF Receiver I Signal Strength Group Displays	UHF RECEIVER I SIGNAL STRENGTH	Meter, continuous scale	Indicates received signal strength	UHF Receiver #1 I-F
	UHF OPERATING	Light, legend, green* (this light is paralled on the display panel and the MCC)	Indicates signal strength is satisfactory for operation, also AFC lockon	"AFC lockon" signal from UHF Receiver #1
	AFC SEARCHING	Light, legend, yellow*	Indicates AFC of receiver is searching	"AFC searching" signal from UHF Receiver #1
	NARROW BANDPASS	Light, legend, white	Indicates that the 500 KC bandpass I-F is in the receiver circuit	UHF Receiver #1
	WIDE BANDPASS	Light, legend, white	Indicates that the 1.5 MC bandpass I-F is in the receiver circuit	UHF Receiver #1
UHF Receiver 2 Signal Strength Group Displays	UHF RECEIVER 2 SIGNAL STRENGTH	Meter, continuous scale	Indicates received signal strength	UHF Receiver #2 I-F
	UHF OPERATING	Light, legend, green* (this light is paralled on the display panel and the MCC)	Indicates signal strength is satisfactory for operation, also AFC lockon	"AFC lockon" signal from UHF Receiver #2

* All illuminated indicators will show color only when energized. When de-energized the background will be white.

TABLE 4-5

RF PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
UHF Receiver 2 Signal Strength Group Displays	AFC SEARCHING	Light, legend, yellow*	Indicates AFC of receiver is searching	"AFC searching" signal from UHF Receiver #2
	NARROW BANDPASS	Light, legend, white	Indicates that the 500 KC bandpass is in the receiver circuit	UHF Receiver #2
	WIDE BANDPASS	Light, legend, white	Indicates that the 1.5mc bandpass is in the receiver circuit	UHF Receiver #2
Receiver Status Group Controls	UHF RCVR NOT READY	Switch, pushbutton, solenoid-held, illuminated, red*. Lights when either or both UHF receivers are first energized or when button is depressed. Corresponding legend lights are on the display panel and the MCC. All lights go out when control 10A2 (UHF RCVR READY) is depressed, and this button is released.	Lights UHF RCVR NOT READY legend lights on the display panel and the MCC	UHF receivers "power applied" signals

* All illuminated indicators will show color only when energized. When de-energized the background will be white.

TABLE 4-5

RF PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
Receiver Status Group Controls (Cont.)	UHF READY	Switch, pushbutton, solenoid-held, illuminated, amber*. Lights when depressed. Corresponding legend lights are on the display panel and the MCC. When button is depressed, button light 10A1 (UHF RCVR NOT READY) and corresponding legend lights go out. This button light goes out when display 8A2 or 9A2 (UHF OPERATING) lights, but button stays depressed.	Lights "UHF RCVR READY" legend lights on the display panel and the MCC; turns out all UHF RCVR NOT READY lights	N/A
UHF Receiver Select Controls	UHF RCVR 1	Switch, pushbutton, illuminated, solenoid-held, white. Released when control 11A2 (UHF RCVR 2) is depressed.	Routes output of UHF receiver #1 to DAP building. Light in button indicates switching has taken place	Verification signal from receiver lights button

* All illuminated indicators will show color only when energized. When de-energized the background will be white.

TABLE 4-5

RF PANEL (CONT'D.)

LOCATION	NOMENCLATURE	HARDWARE	FUNCTION	SIGNAL SOURCE
UHF Receiver Select Controls (Cont.)	UHF RCVR 2	Switch, pushbutton, illuminated, solenoid-held, white. Released when control 11A1 (UHF RCVR 1) is depressed	Routes output of UHF receiver #2 to DAP building. Light in button indicates switching has taken place	Verification signal from receiver lights button
UHF Preamp Select Group Controls	UHF PREAMP 1	Switch, pushbutton, illuminated, solenoid-held, white. Released when control 12A2 (UHF preamp 2) is depressed	Puts UHF preamp 1 in receiver circuit. Light in button indicates switching has taken place	Verification signal from preamps lights button
	UHF PREAMP 2	Switch, pushbutton, illuminated, solenoid-held, white. Released when control 12A1 (UHF PREAMP2) is depressed	Puts UHF preamp 2 in receiver circuit. Light in button indicates switching has taken place	Verification signal from preamps lights button
UHF Noise Figure Group Controls	NOISE INJECT	Switch, pushbutton, momentary	Routes output of noise generator to front end of preamps	N/A
Displays	UHF NOISE FIGURE	Meter, continuous scale	Displays voise figure of circuit of selected receiver (selected by UHF RECEIVER SELECT button) when NOISE INJECT button is depressed	Output of 60 mc I-F amplifier corresponding to selected receiver

* All illuminated indicators will show color only when energized. When de-energized the background will be white.

4.3.2 Console Operation

The following flow diagrams (Figs. 4-15 through 4-18) describe how the console operators will utilize the panel controls and displays in order to carry out the various antenna system functions:

"Console Turn-On and Prepass Readiness Sequence";
"Prepass Preparation, Antenna Controller";
"Boresight Lens Focus Sequence, Antenna Controller"; and
"Lock-on Test, Antenna Controller".

The strongest concentration of attention is on anticipated contingency situations in which the console operators must become aware of the nature of the contingency and make a corresponding recovery response.

The flow diagrams were generated as a paradigm and consequently are not to be construed as final operating procedures. Detailed operating procedures can be found in the following WDL documents:

VTS WDL-TM-SA-911-4 (Data Receiving Function Manual)
WDL-TM-SA-302-3 (Field Maintenance Manual)

NBTS WDL-TM-SA-925-4 (Organizational Maintenance Manual)
WDL-TM-SA-310-3 (Field Maintenance Manual)

4.4 REQUIRED COMMUNICATION NETWORK MODIFICATIONS

The modification of the Data Reveiving antenna required the addition of fourteen equipment cabinets and a T&D console to the D/R buildings at each station. The new equipment created the requirement for additional communication facilities.

The design recommendations made by Human Factors Engineering for the additional communication equipment were based upon the following considerations of the operators and their functions:

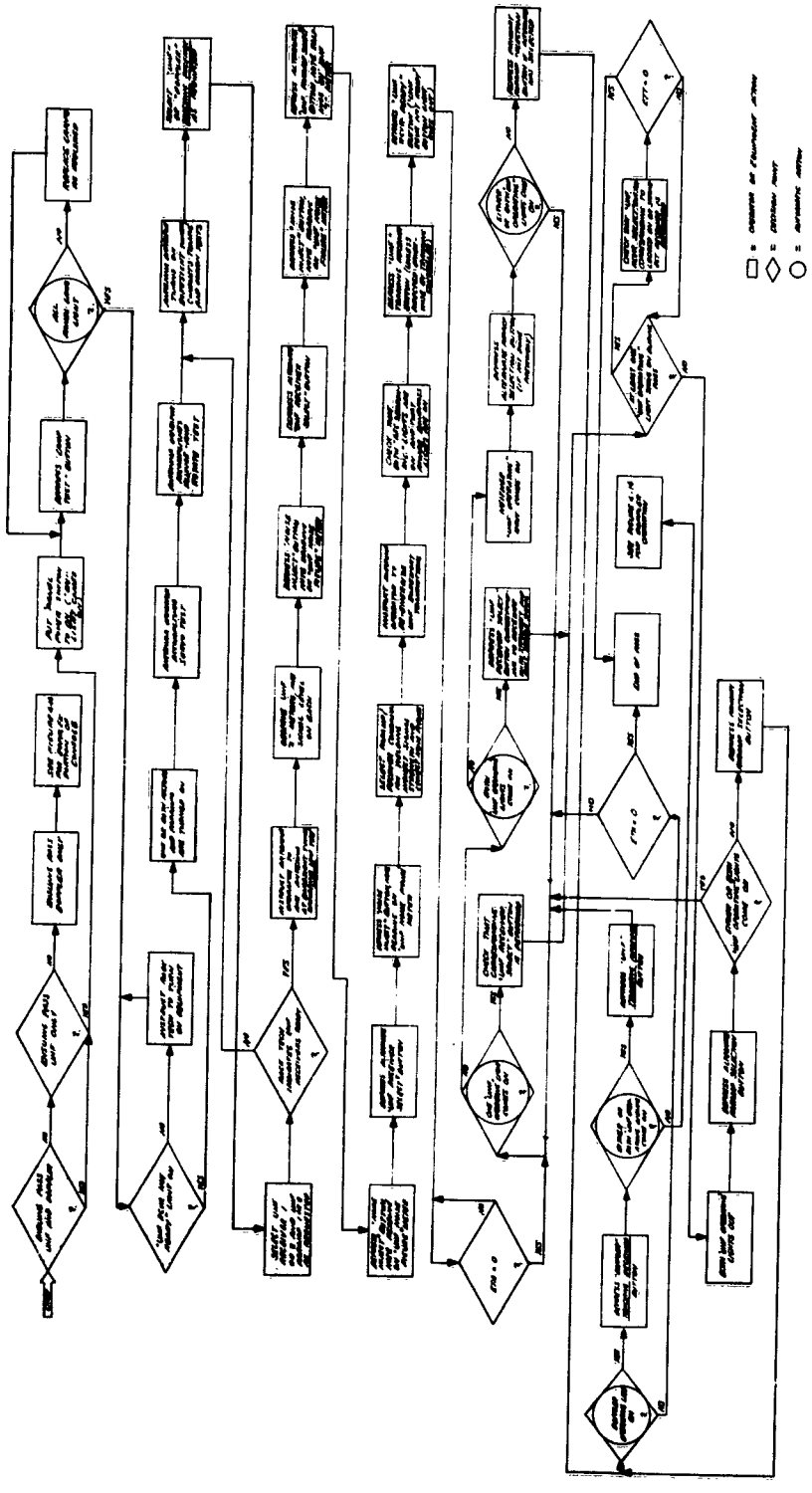


Fig. 4-15 Console Turn-On and Prepass Readiness Sequence

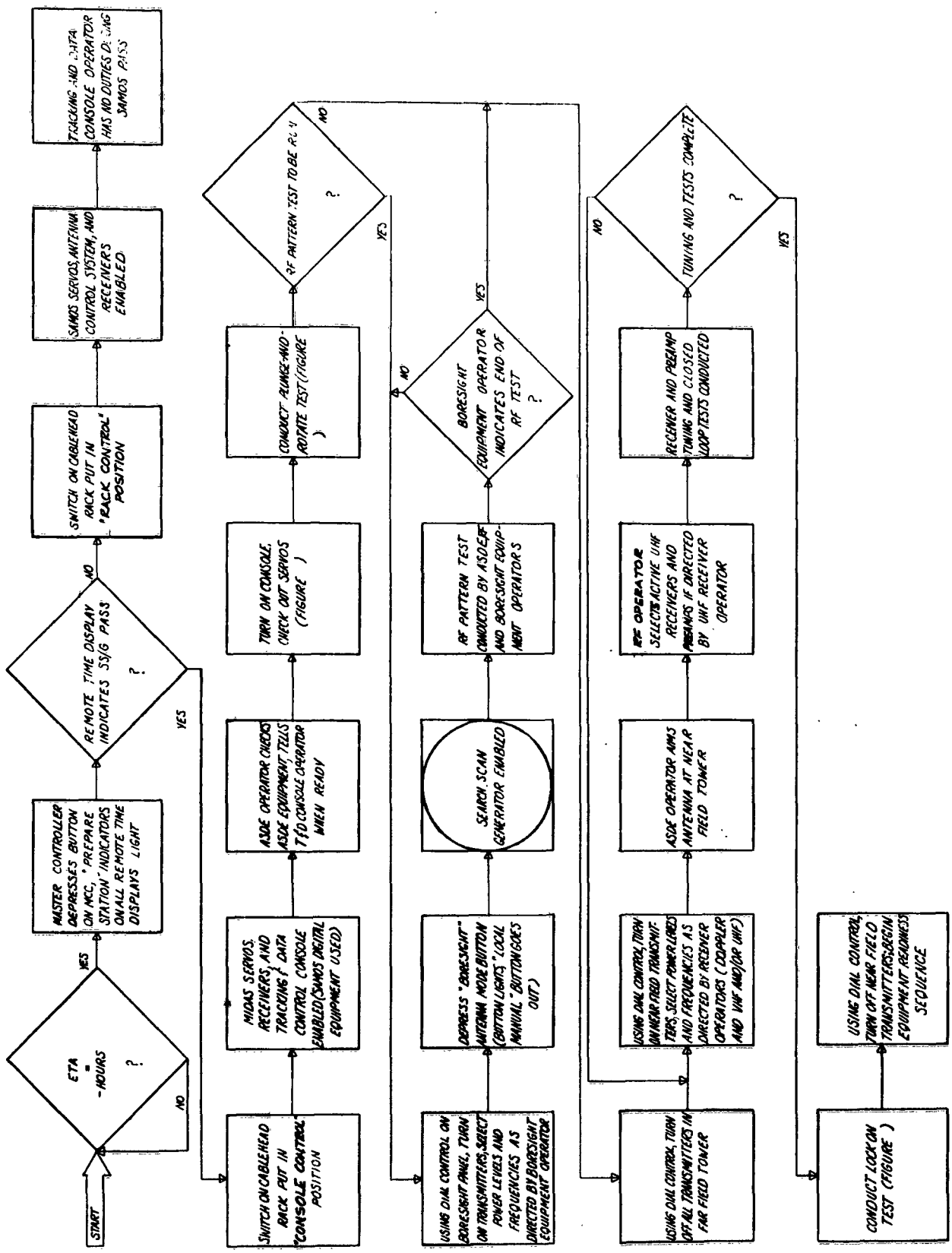


Fig. 4-16 Prepass Preparation, Antenna Controller

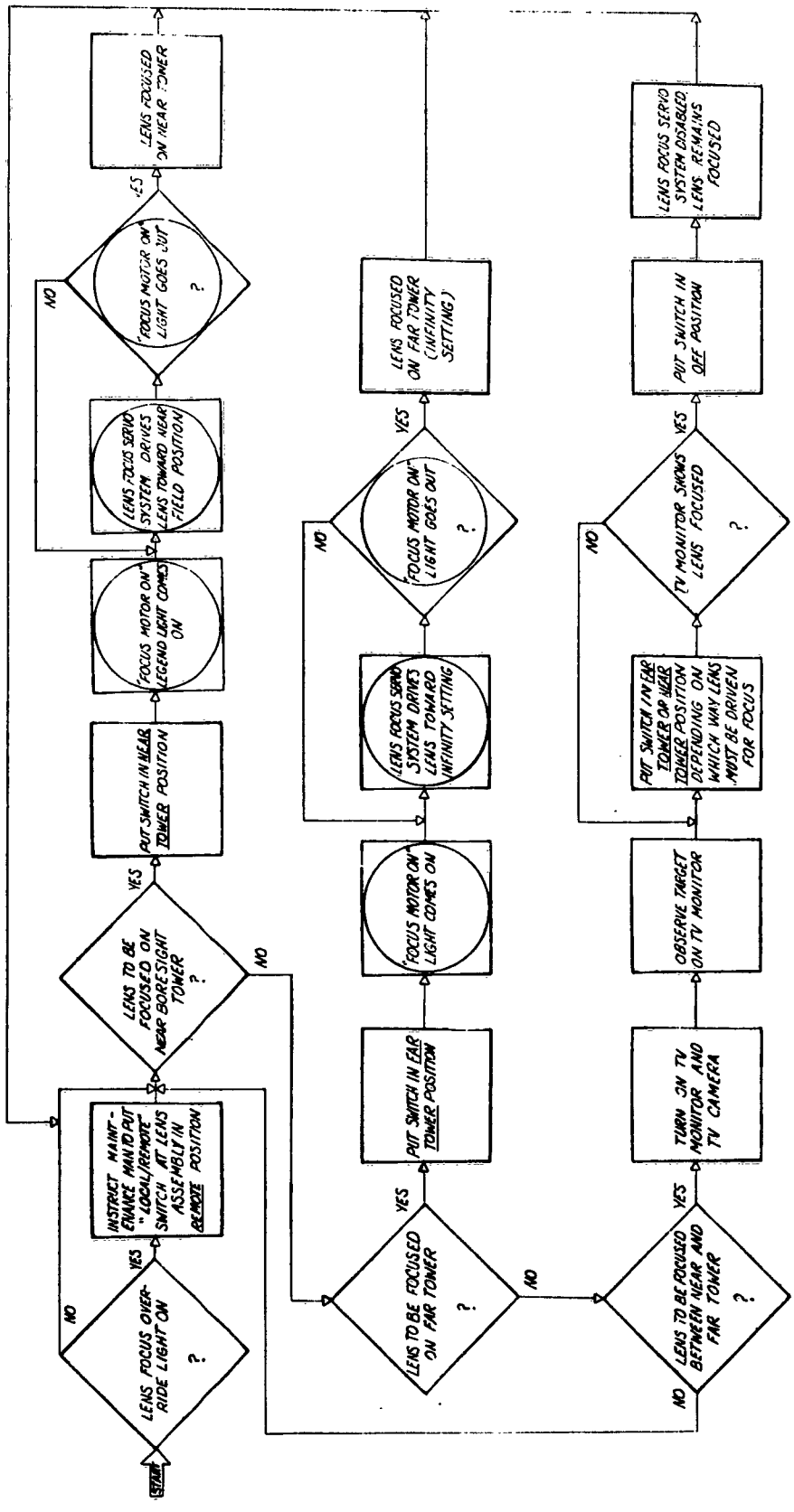


Fig. 4-17 Boresight Lens Focus Sequence, Antenna Controller

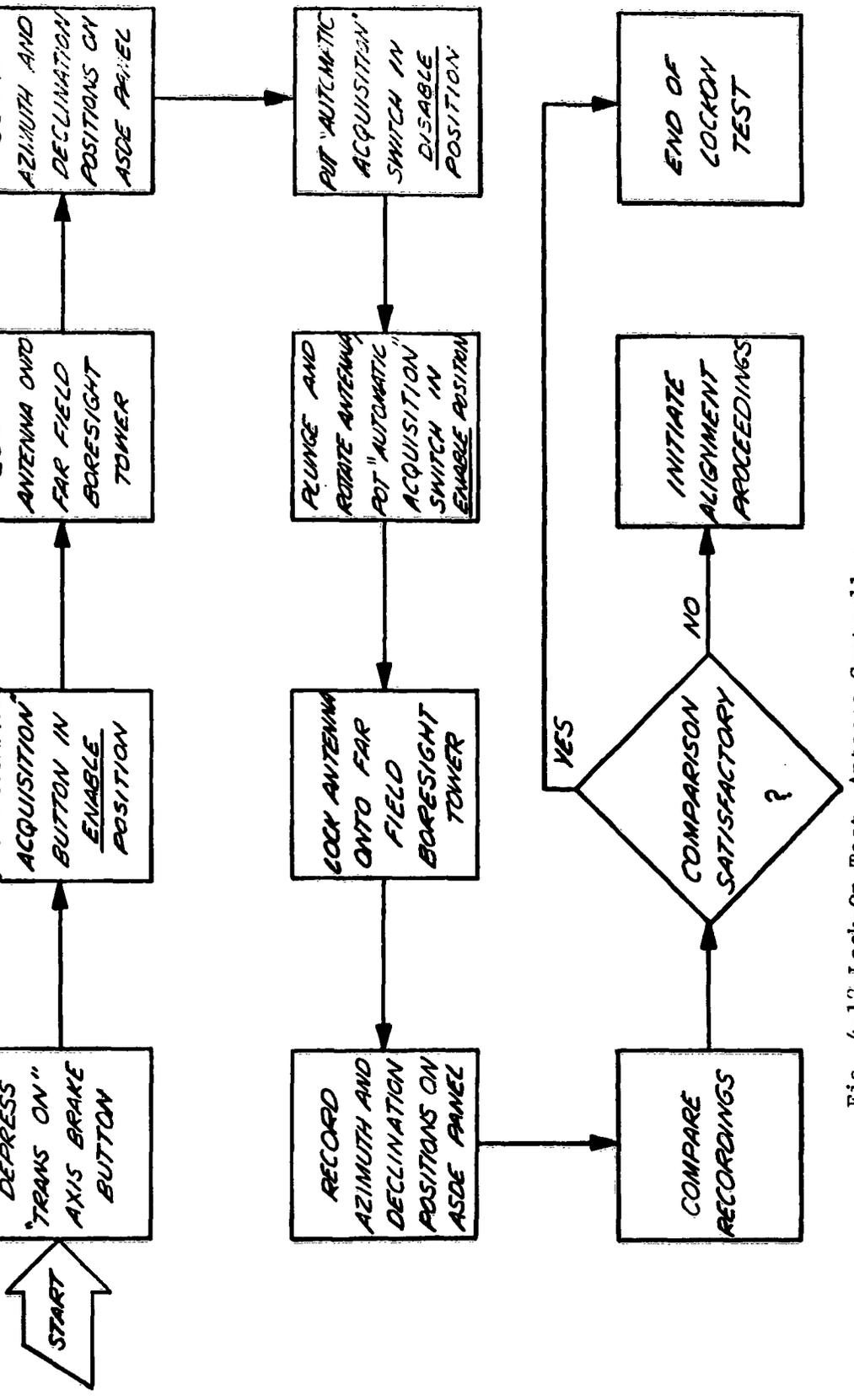


Fig. 4-13 Lock-On Test, Antenna Controller

a. The necessity for information not available through equipment displays or face-to-face contact with other operators,

b. The requirement of certain operators to provide status information,

c. The requirement of certain operators to exert or respond to command or administrative authority , and

d. The optimum location of communication facilities for easy access by the operators using them.

With these considerations in mind, Human Facotrs personnel participated in establishing the new communication networks and the panel and jack locations. Figure 4-19 shows the original design input made by Human Facotrs. WDL drawing E113942 is, in part, a result of this work.

Communication panel locations in the new equipment can be determined from WDL drawings E108934 (Communications Space Allocation, UHF T/D Rcvr. Bldg. SS/H Van); C97-132595 (Elevation Drawing, Front, Frequency Converter, OA-57); C97-132596 (Elevation Drawing, Front, Xmtr., Near Field, Boresight Equipment, OA-118); and C97-132594 (Elevation Drawing, Front, Xmtr., Test Checkout & Calibration, 375 Mc, Normal Channel, OA-120).

In addition to the new communication panels and jack outlets, other changes included in relocation of two jack boxes in the antenna support structure and outer rim of the dish.

EQUIPMENT LOCATION	D/R BUILDING																	ANTENNA		
COMMUNICATION LOCATION	D/R ANTENNA	D/R RECEIVER (SUPERVISORY)	DATA LINK + RECEIVER TEST	D/R VHF	D/R ASDE	ANTENNA INSTR. TER 2	ANTENNA INSTR. TER 4	ANTENNA INSTR. TER 4A	ANTENNA INSTR. TER 5	ANTENNA INSTR. TER 6	ANTENNA INSTR. TER 7	ANTENNA INSTR TER 8	SANBORN RECORDERS	NEARFIELD BORESIGHT XMITTER	DOPPLER REFERENCE XMITTER	FREQUENCY CONVERTERS	ANTENNA CONTROL CONSOLE	BORESIGHT TOWER NO. 3 BASE	BORESIGHT TOWER NO. 3 TOP	
COMMUNICATION UNIT TYPE	P	P	P	P	P	J	J	J	J	J	J	J	P	J	P	J	P	J	J	
P.B.X. EXTENSION NUMBER	316	317	318	319	320								397		395		396	283		
MONITORING FACILITY	Δ	Δ	Δ	Δ	Δ	Δ									Δ		Δ			
1 COMMAND NET		X													X		X			
2 TRACKING NET	X	X	X	X	X								X		X		X			
3B MAINTENANCE + CHECKOUT-UHF D/R BLDG	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
3G PICE NET															X					
3H INSTRUMENTATION + CALIBRATION				X									X							
4 SUPERVISORY NET		X															X			
5 622A COMMAND + T/M NET		X																		

Fig. 4-19 Voice Communications Diagram

SECTION 5

SURVEY OF INTER- AND INTRA-STATION COMMUNICATIONS

5.1 INTRODUCTION

The communications data gathering was first conducted at VTS, then at NHS, and finally at ATS. The VTS and NHS evaluations were conducted primarily to observe the integration of the existing communication equipment with the required operational tasks.

The ATS communication analysis was requested by the Test Wing and is a part of the Human Factors Engineering (HFE) requirement.

The ATS communication analysis, therefore, is included in this report as one of HFE's past-year activities.

Since the communication subsystem is one of the most vital links of any operation, requirements for evaluating other stations still exist and are being planned for the coming year. The stations to be visited include NPS, TTS, HTS, and IOS.

5.2 VTS COMMUNICATIONS

The comments pertaining to the VTS portion of this communication report were made only in reference to the communication equipment of the master console room and the equipment room of the D.A.P. building.

Data sheets (see Figs. 5-1 and 5-2) were prepared prior to the station visit and were filled out at the station as a means of gathering and retaining information. The following comments are based upon observations, personal interviews with equipment and console operators, and information on the data sheets.

STATION: _____

COMMUNICATION DATA SHEET 1

BUILDING: D.A.P.☐ T & D☐ C. T.☐ _____ VAN☐ _____☐

PROGRAM: 239 A☐ 921 C☐ 622 A☐ 698AR☐ AUG.☐

POSITION: CONTROL☐ OPERATOR☐ MAINTENANCE☐ ADMINISTRATIVE☐

EQUIPMENT: PANEL☐ JACKBOX☐ MAINT. JACK☐ SOUND POWER PHONE☐ P.A. ACCESS☐

HOLD☐ S.T.A.☐ A/G☐ SPEAKER☐ RECORD SWITCH☐ VOLUME CONTROL☐

LAMP TEST☐ DIAL☐ ACTIVATED? YES☐ NO☐ FRONT JACK OUTLET_____☐

SIGNAL OFF-ON SWITCH: TOGGLE☐ ROTARY☐ LIGHTED PUSHBUTTON☐

NET SELECT:☐ PUSHBUTTON☐ ROTARY☐ LIGHTED PUSHBUTTON☐

RACK /☐ NUMBER:_____ LOCATION:_____

CONSOLE:☐ FUNCTION:_____

NETS: 1 2 3 4 5 6 7 8 9 _____

INTERFACED ? YES☐ NO☐ PROGRAM:_____

CONFERENCING ? YES☐ NO☐ DIRECTION:_____

ADMIN. PHONE NEARBY ? YES☐ NO☐ DISTANCE:_____

COMM. EQUIP. LOCATION: GOOD☐ BAD☐ _____

NET SELECT ASSIGNMENTS

BUTTON 1:_____ BUTTON 7:_____

BUTTON 2:_____ BUTTON 8:_____

BUTTON 3:_____ BUTTON 9:_____

BUTTON 4:_____ BUTTON 10:_____

BUTTON 5:_____ BUTTON 11:_____

BUTTON 6:_____ BUTTON 12:_____

REMARKS:_____

_____

_____

DIAGRAM LAYOUT (IF NECESSARY)

DATA TIME_____

Fig. 5-1 Communication Data Sheet 1

STATION: _____

ROOM #: _____

CY #: _____

COMMUNICATION DATA SHEET 2

OPERATOR POSITION:

CONTROL ☐ OPERATOR ☐ MAINTENANCE ☐ ADMINISTRATIVE ☐ CONSOLE ☐ RACK ☐

PANEL ☐ JACKBOX ☐ JACK ☐

BUILDING:

DAP ☐ T & D ☐ C. T. ☐ _____ VAN ☐ _____ ☐

OPERATOR KNOWLEDGE:

CONFERENCING? YES ☐ NO ☐ ACTIVATED? YES ☐ NO ☐

P. A. ACCESS ? YES ☐ NO ☐ ACTIVATED? YES ☐ NO ☐

NET SELECT? YES ☐ NO ☐

MODIFICATION/S REQUESTED? YES ☐ NO ☐

NET SELECT CHANGE ☐ MORE NETS ☐ FROM _____ TO _____

LESS NETS ☐ FROM _____ TO _____ MORE FLEXABILITY ☐

INTERFACING ☐ SPECIAL TIE-IN ☐ BETTER CONTROL ☐ BETTER PANEL DESIGN ☐

UNNECESSARY FEATURES ☐ _____

_____

_____

NECESSARY FEATURES ☐ _____

_____

_____

RECOMMENDATIONS: _____

_____

_____

_____

DATA TIME _____

Fig. 5-2 Communication Data Sheet 2

5.2.1 VTS Communication Equipment

The communication equipment at VTS was not standardized in any way. Seven different types of communication panels, ranging from recorder panels to jack outlets for the plotboards, existed in the master console and equipment rooms. Jack outlets in back of the communication panels (maintenance jack outlets) differed in type from the operational jack outlets in front of the panels. The maintenance jack outlets were never used because headsets with the male type jacks required for the maintenance jack outlets could not be obtained. As a result, the maintenance operations in the back of the racks were conducted with front panel headsets by stretching the phone cords over the top or around the side of the racks.

5.2.2 VTS Communication Equipment Locations

In general, the communication equipment locations were good, but could have been better. At two of the operational positions, the operator had to walk about 25 to 30 feet before having access to a dial phone. In another instance, the communication control panel was 50 feet from the operating position auxiliary jack outlet.

The rack locations for the communication equipment had been placed in areas other than those recommended by Human Factors Engineering. The rack communication panel should have remained in the recommended areas. In one case, the utility shelf was positioned right below the communication panel: test equipment placed on that shelf obscured the entire communication panel.

5.2.3 VTS Communication Net Configuration

The net configuration for VTS consisted of 21 nets: 8 operational nets including all stations, 12 nets divided into maintenance and check-out groups, and 1 back-up net including all the operational stations. It was the feeling of the Communications Officer that the maintenance and checkout nets should be kept separate from the operational nets. Further, the maintenance and checkout nets were never to be used for operational nets.

VTS has unique net requirements because launch facilities are incorpprated into the operational net configuration. Other stations do not have this launch communication requirement; therefore, the total nets for the other stations are less in number.

5.2.4 VTS Communication Panel Hardware

The communication panel hardware was not totally activated, causing some delays during operational activities. The main difficulty was caused by the fact that the P.B.X. dial was not put into operation on most of the communication panels, thereby requiring the operators to make extra trips to the nearest P.B.X. phones.

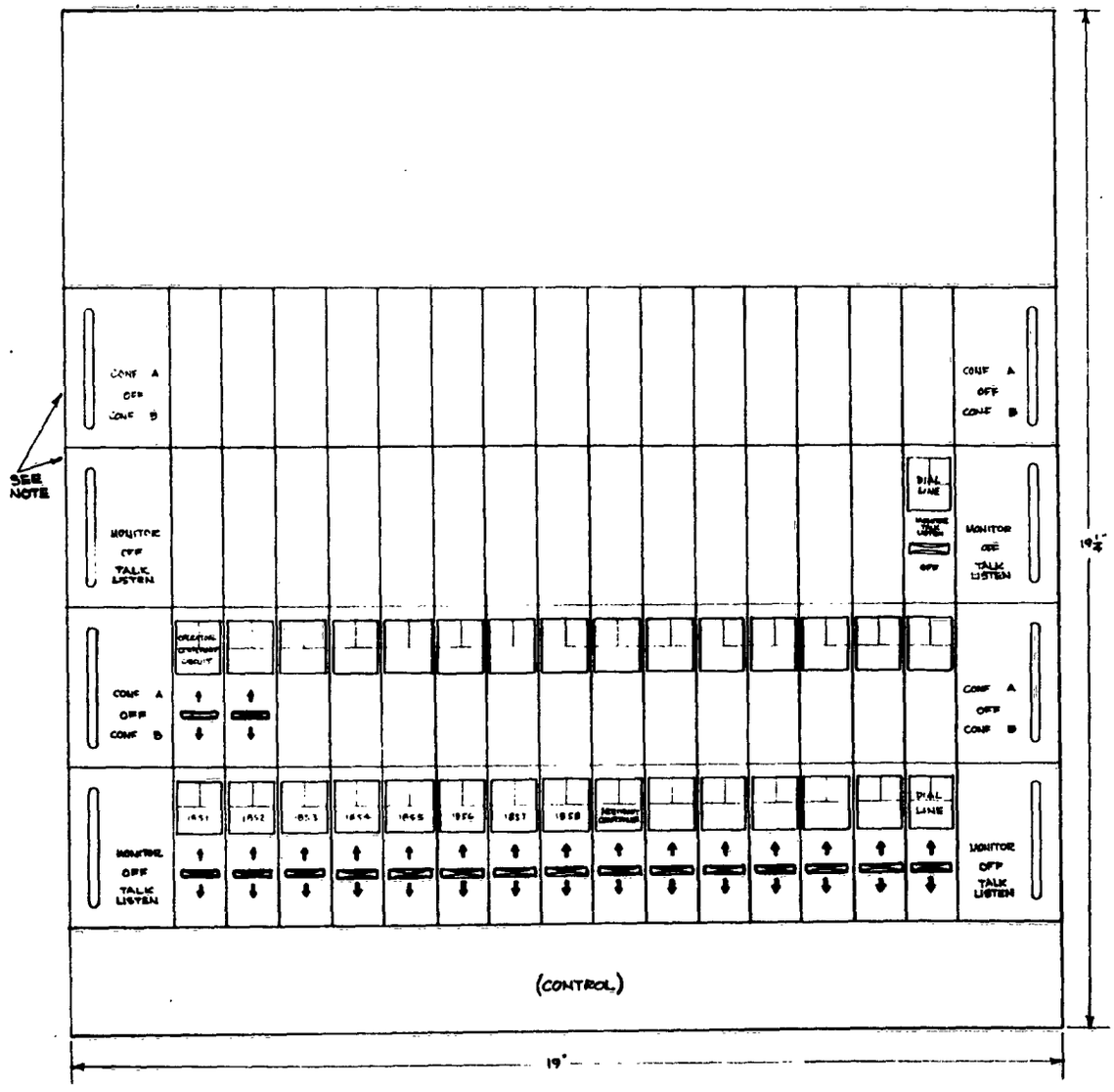
Other operational delays were caused by the absence of the "lamp test" to check the indicator switches and the volume control for the headsets. There were also incorrectly labeled operational net select switches and unlabeled rubber-booted toggle switches. The functions of the latter were completely unknown to the operations personnel.

5.2.5 New VTS Modular Communication Panel

New VTS modular communication panels were being installed in the control areas. The new panel replaces some of the old Kellog equipment and facilitates operational procedures.

Figure 5-3 shows the layout of the new communication panel now installed at VTS. There are two types of 3 in. by 19 in. net select panels: one for conference "A" and "B", and the other for direct point-to-point select operation. These two panels must be installed in pairs in order to achieve the desired operational capability.

The conference "A" position on the panel is used for monitoring, and the conference "B" position is used for talking into the conference net as well as for monitoring. It should be noted that the conference "A" and "B" panel can not be used unless a net on the direct point-to-point select panel below it is activated or in use and the facilities control switch for conference net "A" or "B" is activated.



NOTE

THESE PANELS ARE DUPLICATES OF PANELS PICTURED BELOW.
THIS COMBINATION OF PANELS MUST ALWAYS BE USED AS A PAIR.

Fig. 5-3 New VTS Modular Communication Panel

Each communication panel consists of 15 one-inch modules, each containing one relay toggle switch, one light indicator, and one AMP connector in the module rear (Fig. 5-4). Each module is wired as a different circuit and can be removed from the panel by pulling on the toggle switch to disengage the AMP connector. The physical size of each module is 1 in. by 3 in. by 5 in. The indicator light on each module is split into three sections (Fig. 5-5). Various combinations of lights denote the utilization of the communication net.

The 2 in. by 19 in. panel, located at the bottom of the communication panels, is the control panel for the communication equipment (Fig. 5-6). The panel houses two jack outlets, a 1/2-in. POWER ON indicator, a 3/8-in. momentary LAMP TEST pushbutton, eight Micro switches, and two volume controls. The eight Micro switches on the control panel are grouped into five switches for FACILITIES CONTROL and three switches for COMMON CONTROL.

The FACILITIES CONTROL switches consist of two activating switches for monitoring on conference nets: CONFERENCE A MONITOR and CONFERENCE B MONITOR. Three other switches are presently unassigned.

The three COMMON CONTROL switches consist of the DIAL LINE HEADSET HANDSET TRANSFER switch, the BUZZER CUTOFF switch, and the HOLD switch. The DIAL LINE HEADSET HANDSET TRANSFER switch transfers administrative dial calls onto the operational headset. The BUZZER CUTOFF switch turns off the audible signal, leaving on only the visual signal. The HOLD switch holds any incoming administrative calls on the dial phone until the operator from the operational net is clear.

One of the volume controls on the HEADSET control area of the panel controls the monitor (receiver) volume level, and the other controls the voice (transmitter) volume level. Both jack outlets for the headset are the screw-on pin type outlets. One outlet is used continuously for operations, and the other is available as an auxiliary jack outlet.

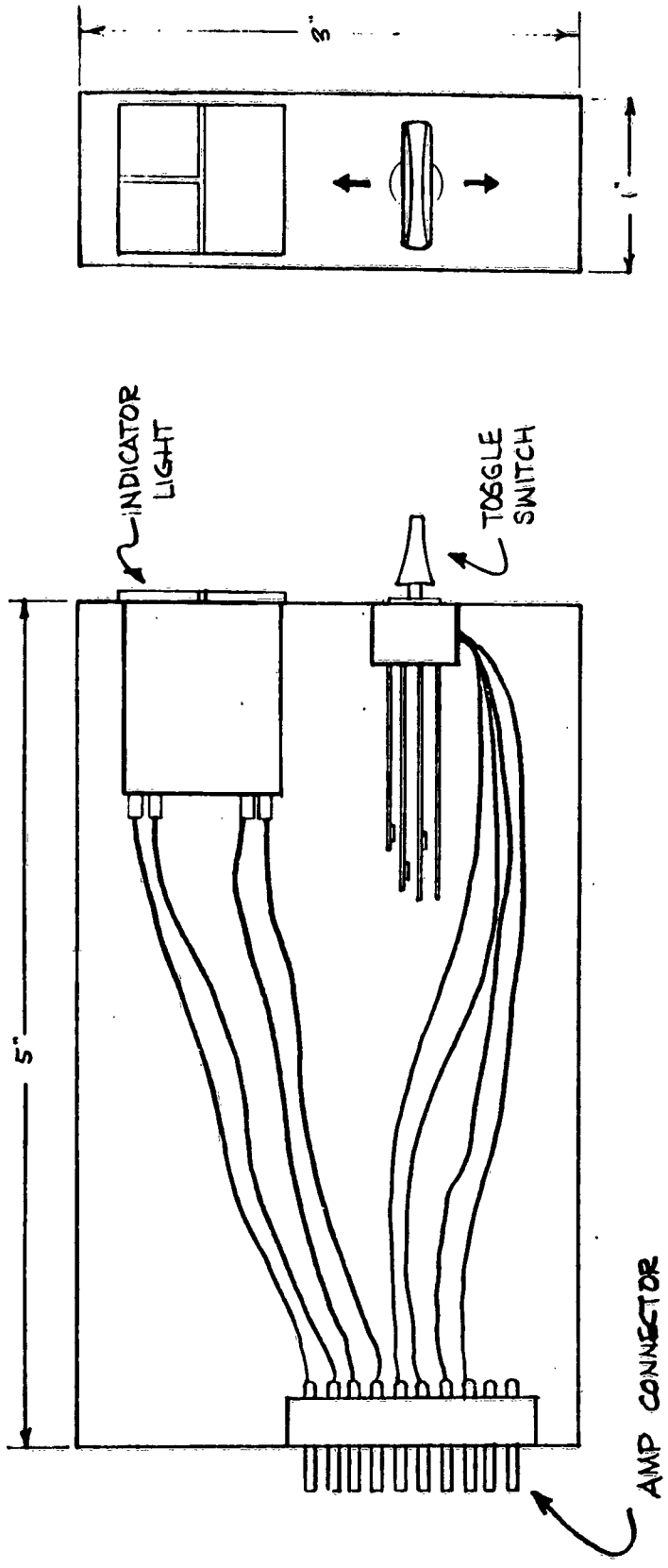
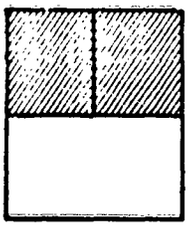
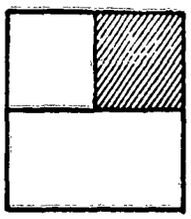


Fig. 5-4 VTS Communication Panel Module

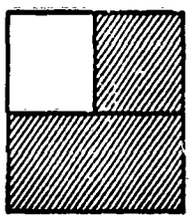
CONFERENCE PANEL



BOTH TOP LIGHTS TURN ON WHEN ON MONITORING POSITION ON THAT NET.

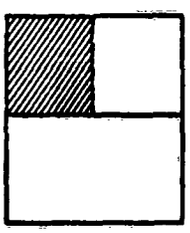


RIGHT TOP LIGHT TURNS ON WHEN THAT NET IS BEING UTILIZED.

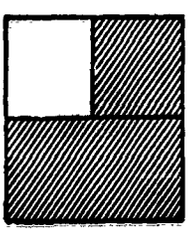


RIGHT TOP LIGHT AND BOTTOM LIGHT TURN ON WHEN ON TALK AND RECEIVE POSITION ON THAT NET

DIRECT NET PANEL



LEFT TOP LIGHT TURNS ON WHEN ON MONITORING POSITION ON THAT NET.



RIGHT TOP LIGHT AND BOTTOM LIGHT TURN ON WHEN ON TALK AND RECEIVE POSITION ON THAT NET.

DWG A 12710

Fig. 5-5 Communication Panel Split-Lens Indicator Configurations

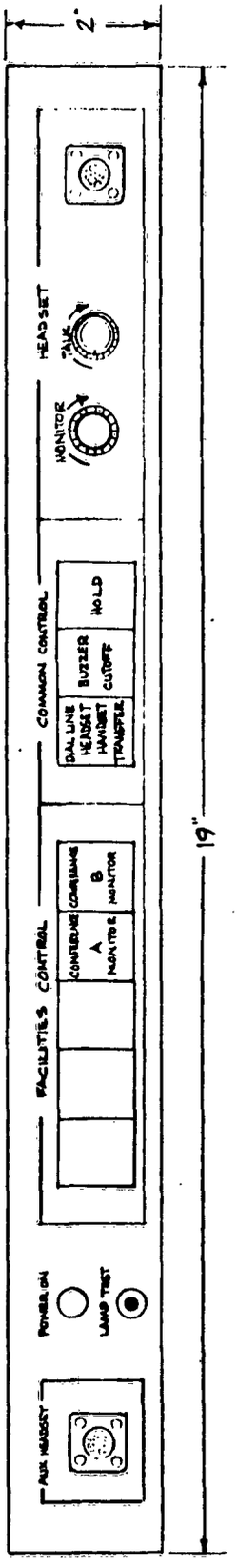


Fig. 5-6 VTS Control Panel for Communication Panel

The momentary LAMP TEST pushbutton is used to check all conference and operational net light indicators. Each conference and operational net panel combination assigned to a control panel uses the one LAMP TEST pushbutton. The POWER ON lamp of the control panel indicates when power is supplied to the communication panels.

The net signalling is automatically activated by switching the direct net select toggle switch to the talk monitor position. The signal will remain activated intermittently until the signaled operator answers the net called. A speaker monitor facility may also accompany the communication control panel and the set of net and conference select panels.

5.2.6 Human Factors Engineering Comments

Although the new control area communication panels are installed to facilitate operational procedures, they fall short of the desired human engineering approach to design and ease of operation. This new panel requires more human action than the simple communication panels presently being used at other stations (ATS and TTS).

5.3 NHS COMMUNICATIONS

The comments pertaining to this portion of the report were derived from an on-station survey of the communication subsystem. Observations, personal interviews with console and equipment operators, and data sheets similar to those used at VTS were incorporated in the study.

5.3.1 NHS Communication Equipment

The communication equipment used at NHS was standardized, but not to any great extent. The previous program communication equipment and the equipment presently being used represented six types of panels and no (3) net select jackboxes.

One of the greatest operational setbacks involved the lack of monitor speakers on the communication panels. At certain operator positions, additional dial phones were supplemented to handle additional administrative calls. The speaker monitors were remote, and the controls for the monitors were in locations away from the operator's position.

Other items which caused confusion were components such as the net select release button. The release button would release any one of the net select buttons activated in the first row of six buttons, but could not deactivate any one of the net select buttons depressed in the second or third row. The net select button depressed in the second or third row could only be deactivated by partially depressing one of the buttons in the same row.

The line volume level dropped off from time to time; therefore, the operators in the high ambient noise level areas added transistorized line amplifiers to their headsets to compensate for the background noise.

As compared with VTS, however, all dial phones on the communication panels were activated and all net select buttons were correctly identified and clearly labeled. Furthermore, the communication jack outlets in back of the communication panels were of the same type as those on the front, which enabled the same type of headsets to be used for operations on either side. Although the public address system was designed as a ten-zone system, it is used primarily as a one-zone system.

5.3.2 NHS Communication Equipment Locations

The NHS communication equipment locations were good, but could be improved. On-station modifications of the equipment locations placed some of the communications panels in areas not agreeable with good human engineering practice: on top of the writing shelf of the M.C.C., one communication panel below the other, jack outlets, 4-1/2 in. off the floor hidden under a door, and so forth.

The actual locations of the communication equipment in the building and vans at NHS are shown in Figs. 5-7 through 5-14.

5.3.3 NHS Communication Net Configuration

The net configuration for NHS consisted of 13 nets, one S.T.C. hotline, and one special net. During operations, five full nets are in use for tracking and commanding functions.

The 13 nets are identified as follows:

1 Command net

2 Tracking net

3A Maintenance and Checkout, D.A.P. Building

3B Maintenance and Checkout, D/R Building

3C Maintenance and Checkout, A/T Building

3D Maintenance and Checkout, C/T Building

3E 698BJ net

3F S/S F net

3G PICE net

3H Instrumentation and Calibration

4 Supervisory net

5 Discoverer Command and T/M net

6 Discoverer Tracking net

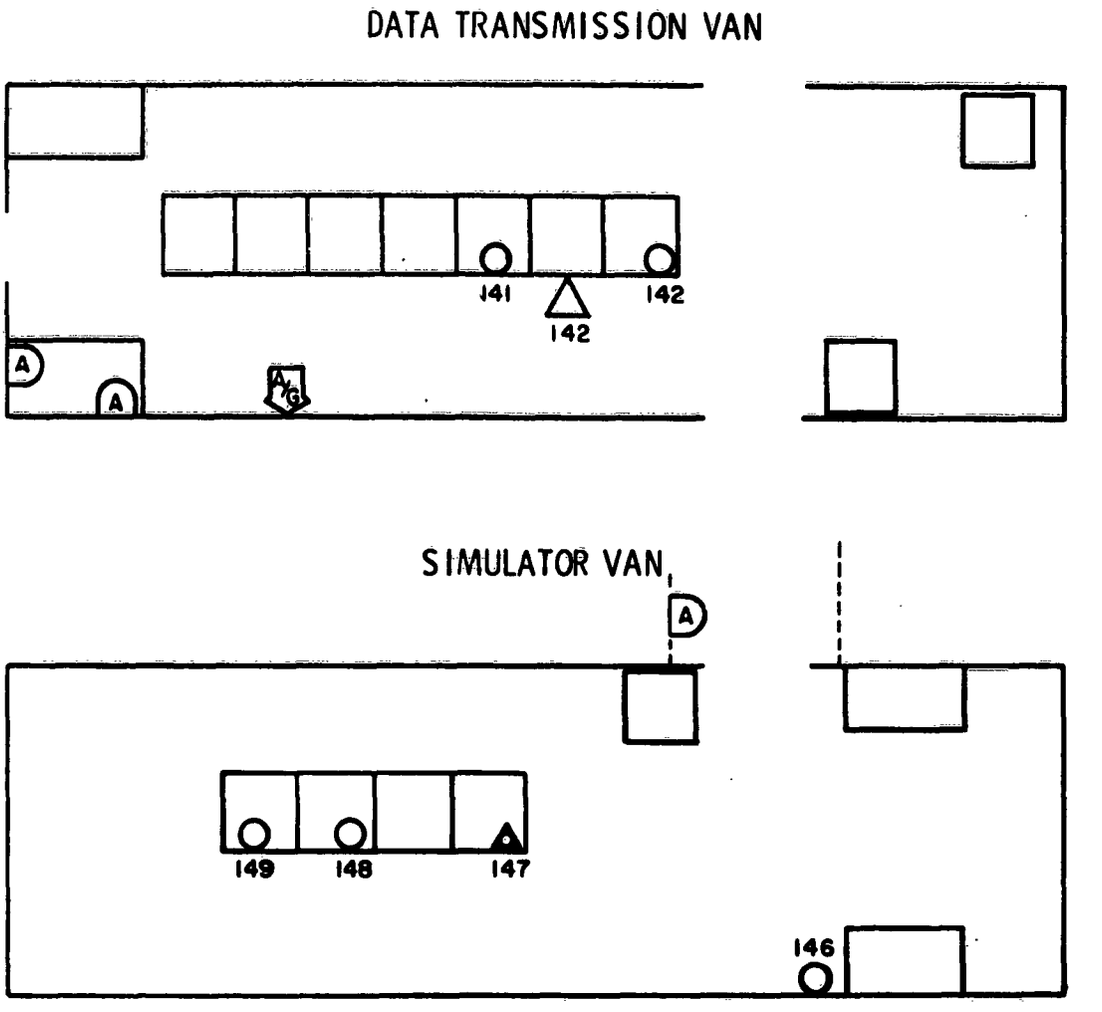


Fig. 5-7 Data Transmission and Simulator Vans

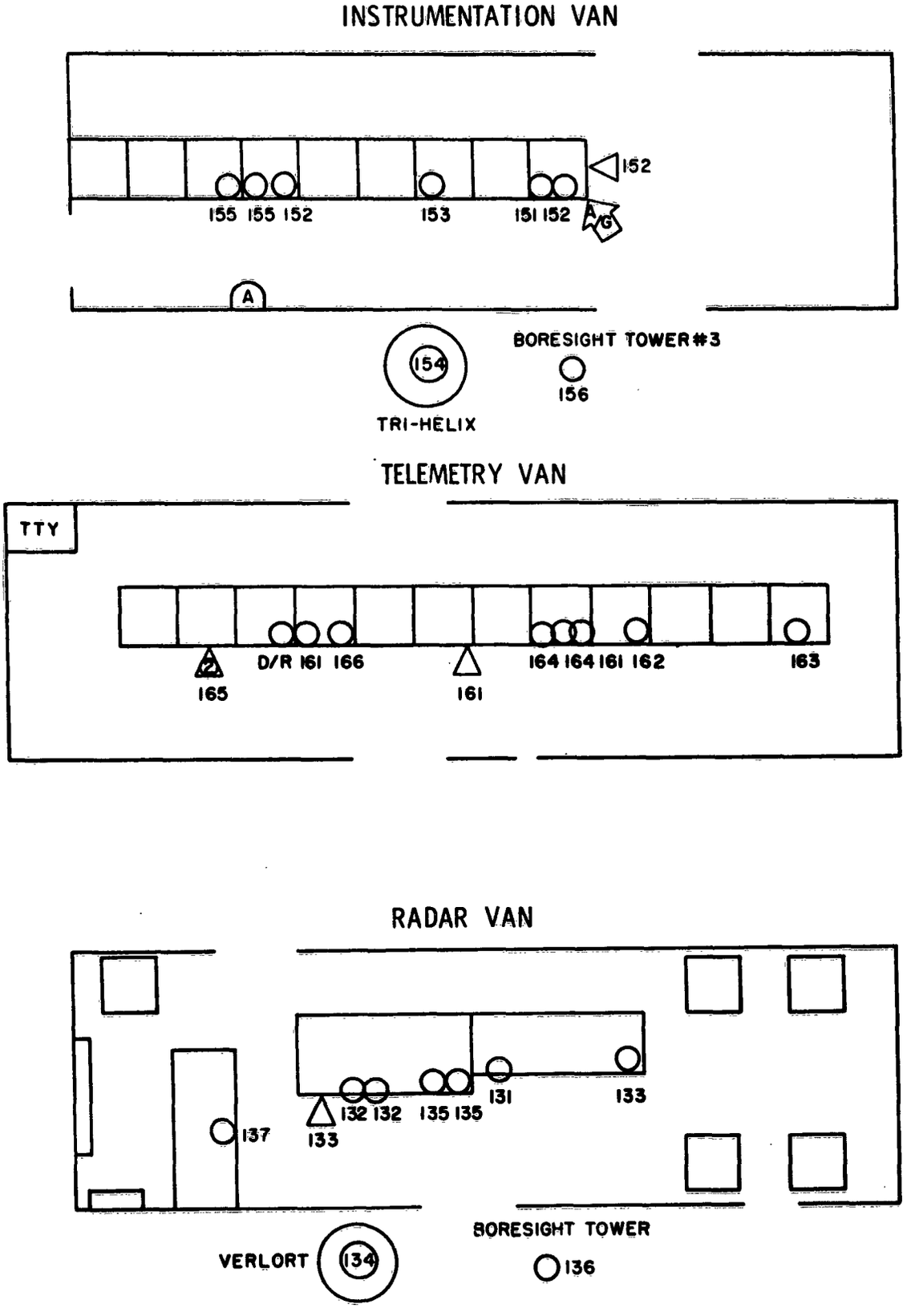


Fig. 5-8 Instrumentation, Telemetry and Radar Vans

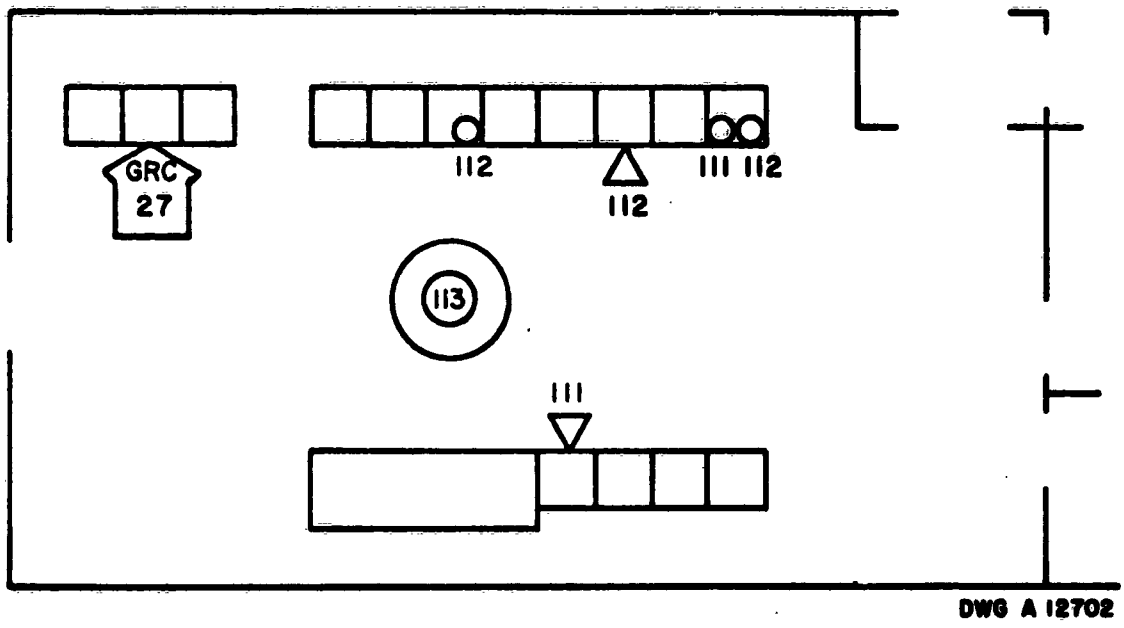
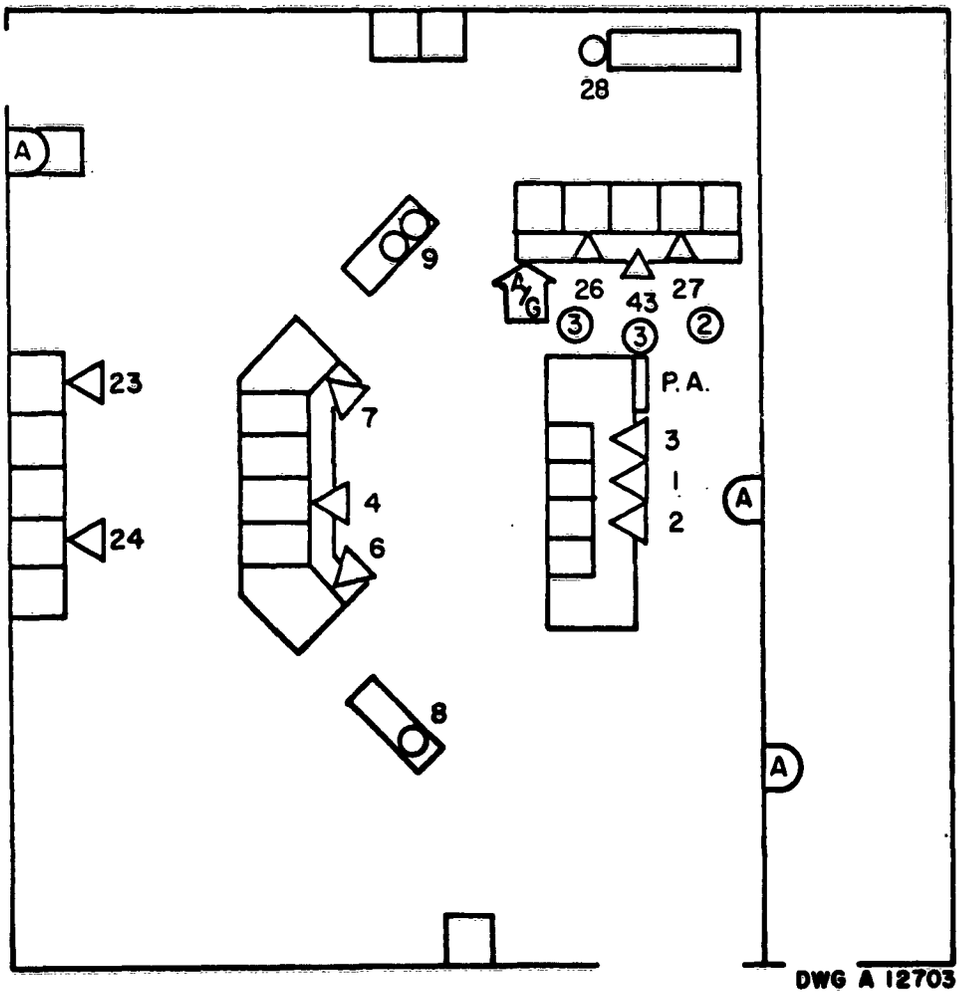


Fig. 5-9 NHS Command Transmitter Building



Fog. 5-10 NHS Control Room #166, D.A.P. Building

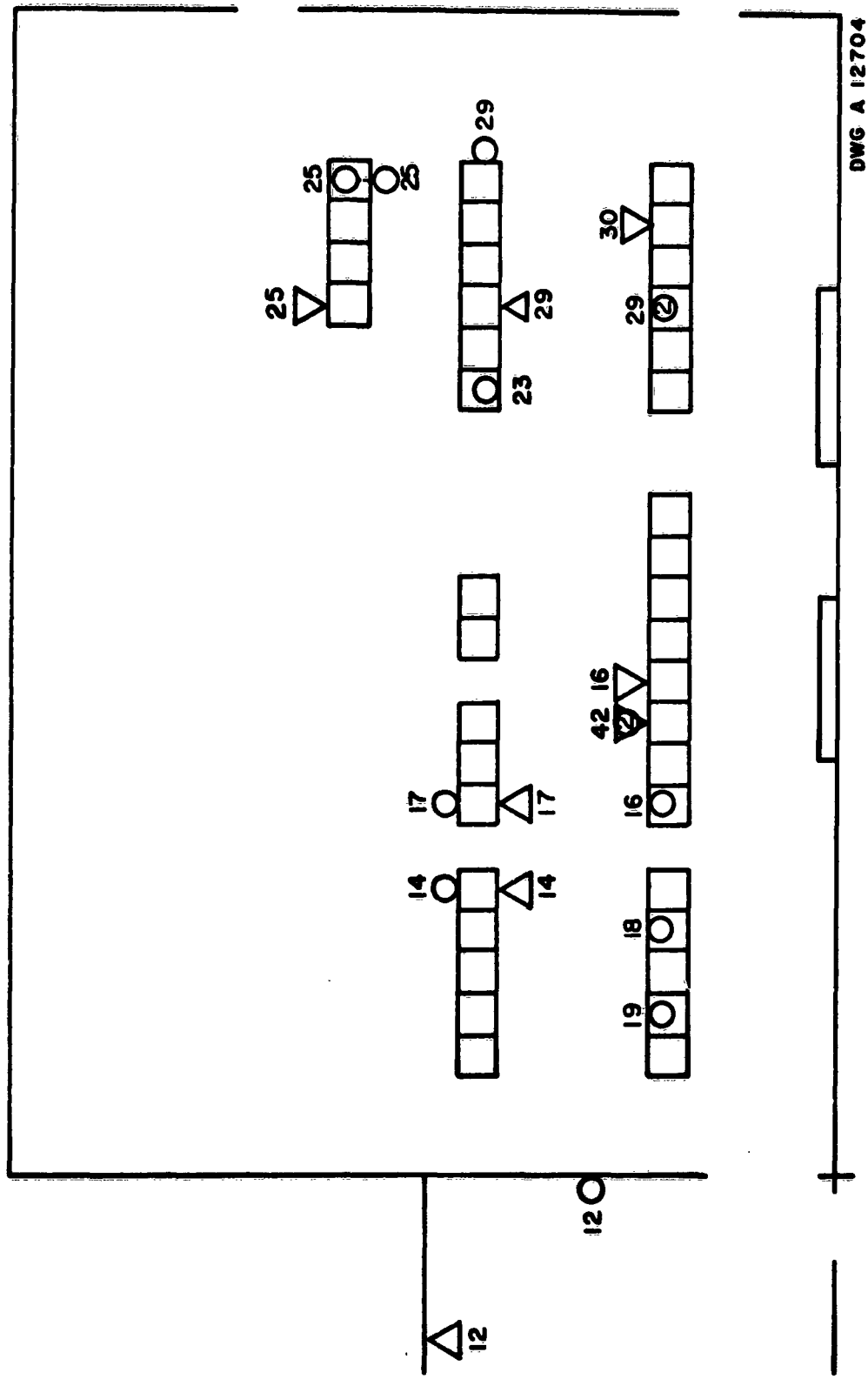


Fig. 5-11 NHS Acquisition, Tracking, and Control Room #167 D.A.P. Building

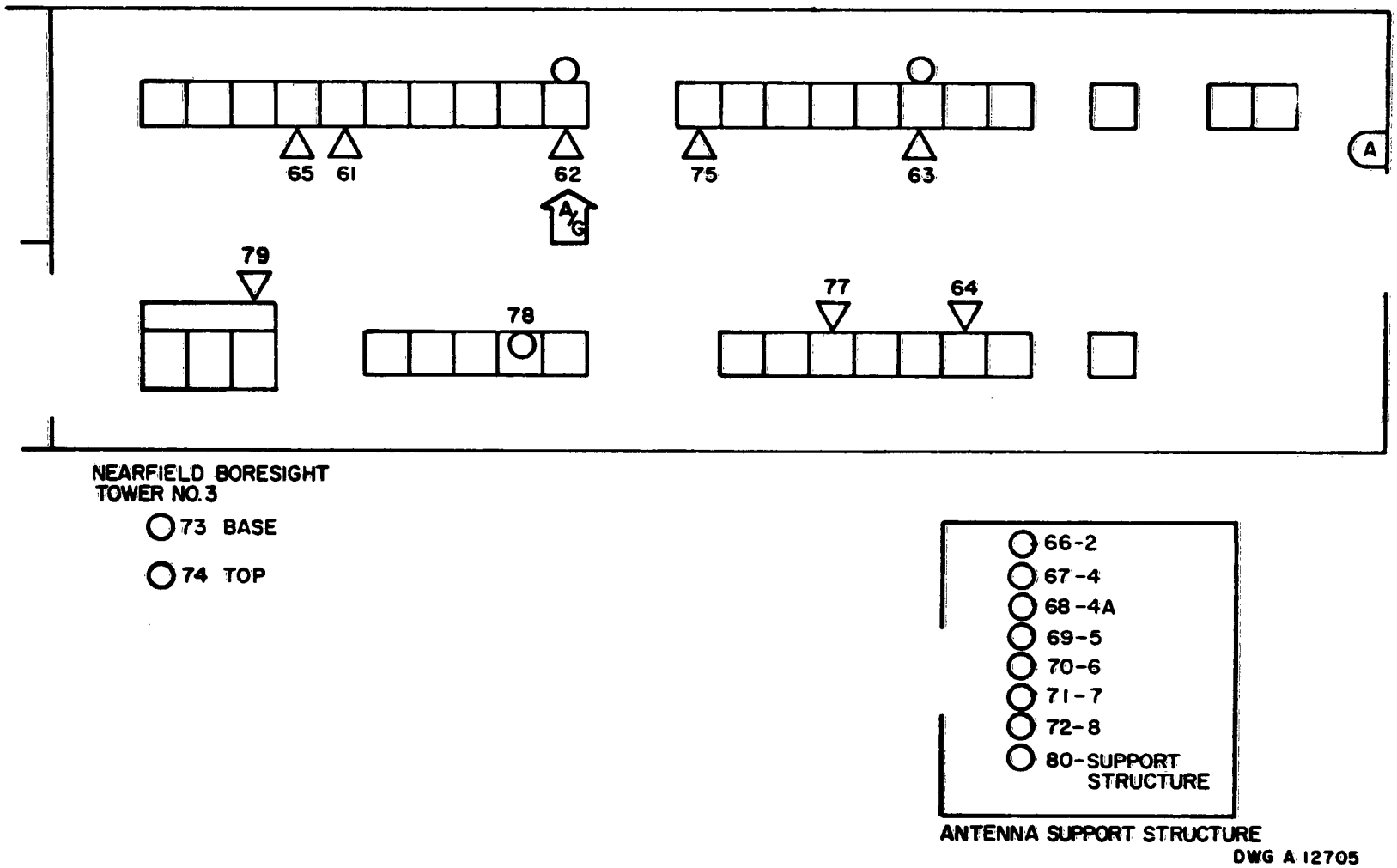
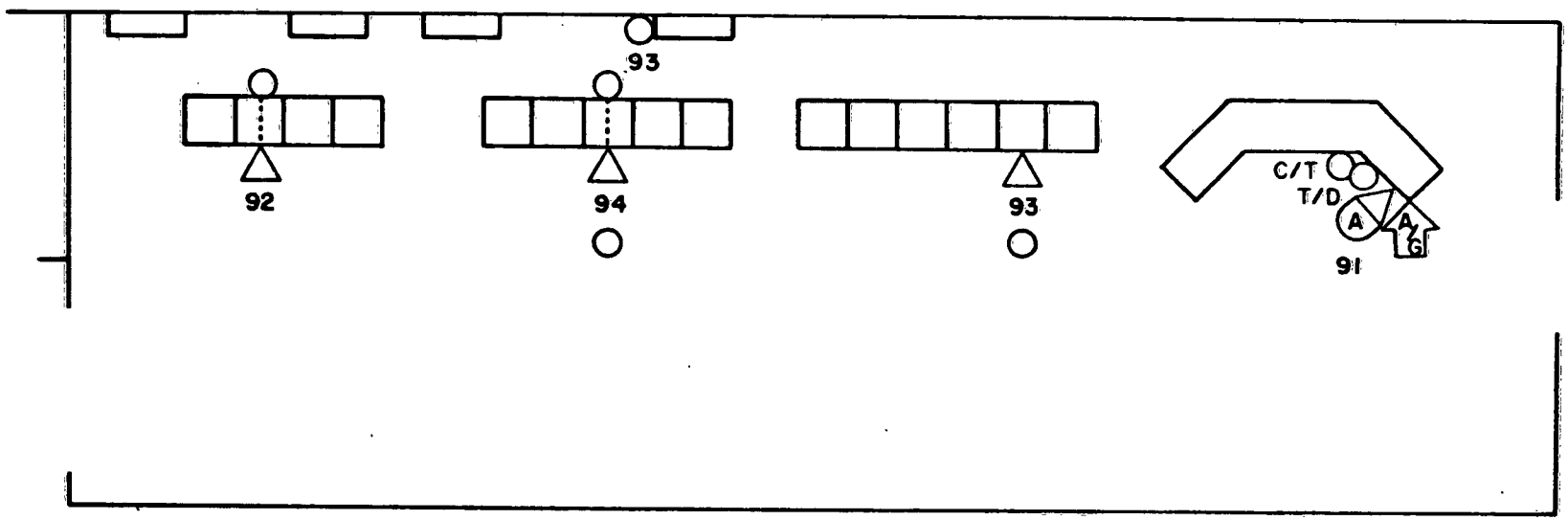
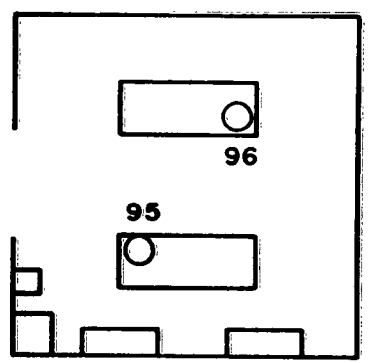


Fig. 5-12 NHS Data Receiver Building



BORESIGHT TOWER #2

- 99 BASE
- 100 TOP
- 97 BASE TOWER #1
- 98 TOP TOWER #1



ANTENNA SUPPORT STRUCTURE

Fig. 5-13 NHS Angle Tracker Building

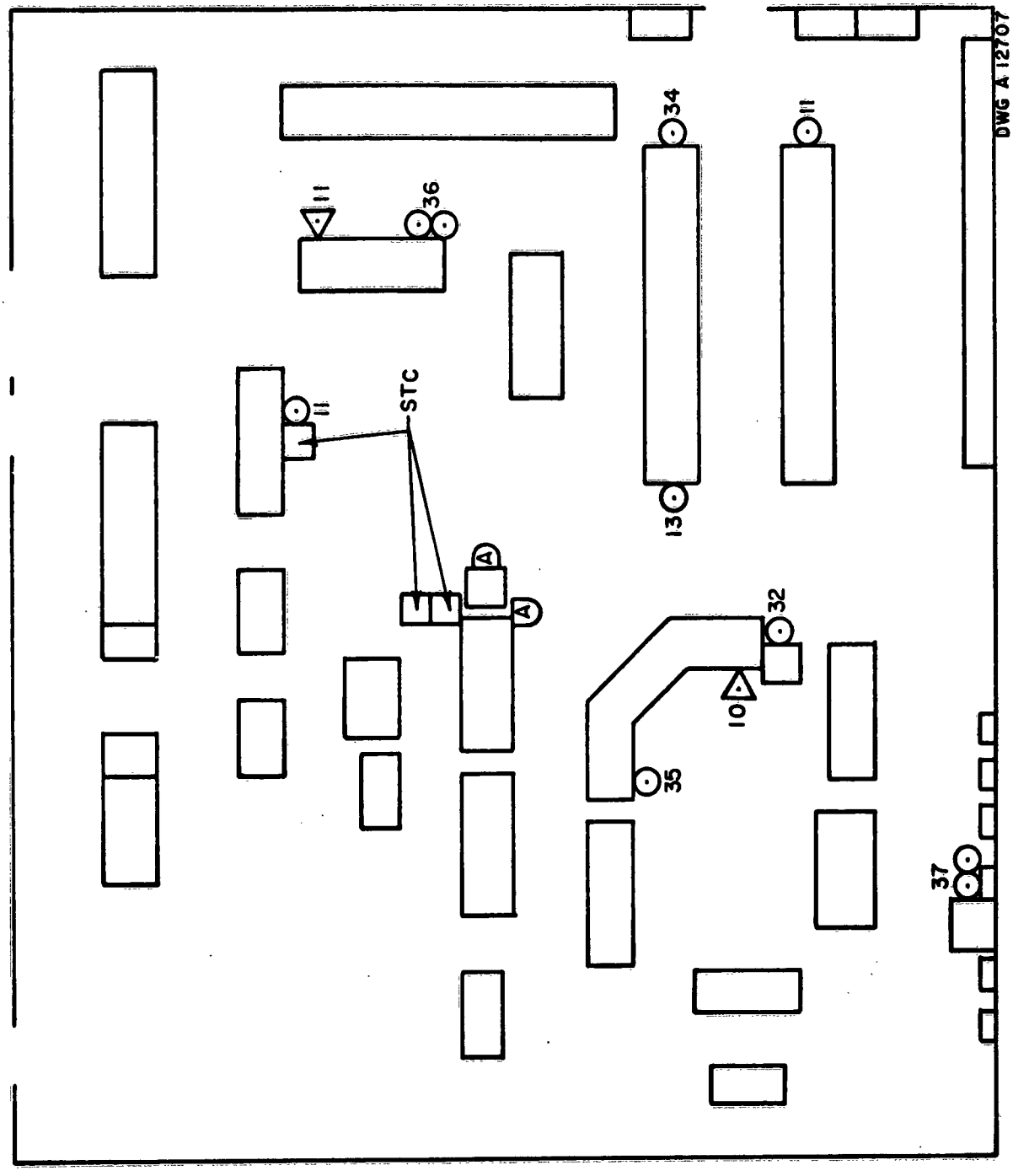


Fig. 5-14 NHS Computer Room #175, D.A.P. Building

Since N.H.S. has special project operations going on from time to time, it was felt that separations were necessary in the net configuration as listed above. If a new program board communication design is to be used for the future system, five operational nets could easily handle the whole operational system.

5.3.4 NHS Communication Panel Hardware

The NHS communication panel hardware is not the approved military standard type. The net select pushbutton control surfaces are smaller than the required control surface diameter stated in Military Standard 803. The same switch is also used to activate the signal "on-off" function with an additional twisting control motion which is quite confusing.

A highly desirable component which was not included on any panel is a "lamp test" pushbutton for checking the indicator lights of all the net select switches. Several lights were out on the communication panels, and it was quite difficult to determine which nets were activated. Furthermore, unlabeled toggle switches were present in the control areas, some of which were placed in awkward locations.

5.3.5 NHS Human Factors Engineering Comments

The existing NHS operational communication equipment handles the operational system adequately, but could be improved by the incorporation of standardized components and Human-Engineered communication panels.

Flexibility and adaptability to various operational and administrative systems were lacking because of the absence of a speaker monitoring facility on the operational communication panel.

Additional equipment mounted on the communication panel at a later date should have been of the same type as the rest of the control components on the panel, since both types perform the same control functions.

There should have been closer coordination between the manufacturer and Human Factors Engineering on the design of the communication panels. An operational communication panel utilizing a new concept in communication operation is being designed at present for NHS.

5.4 ATS COMMUNICATIONS

The communication subsystem described in the following paragraphs is presently installed and operating at ATS. The operations described are typical of the tracking, commanding, prepass, and postpass functions of ATS.

The ATS communication survey was conducted in much the same manner as those for VTS and NHS. However, several exceptions made possible a more complete analysis of the ATS communication subsystem:

a. More time was spent at ATS

b. Several actual tracking operations were monitored, and

c. Personal interviews were held with all operators.

5.4.1 General Comments

The operational procedures, design, placement, and allocation of the communication equipment was far superior at ATS than at NHS or VTS. The operators were completely satisfied with the communication equipment, which had been designed specifically for their operational system.

Although the Human-Engineered communication panels were not manufactured with the appearance and hardware recommended by Human Engineering (Fig. 5-15), the panel produced by the manufacturer (Fig. 5-16) remained the same. As a result, the operational procedures were not affected in any manner.

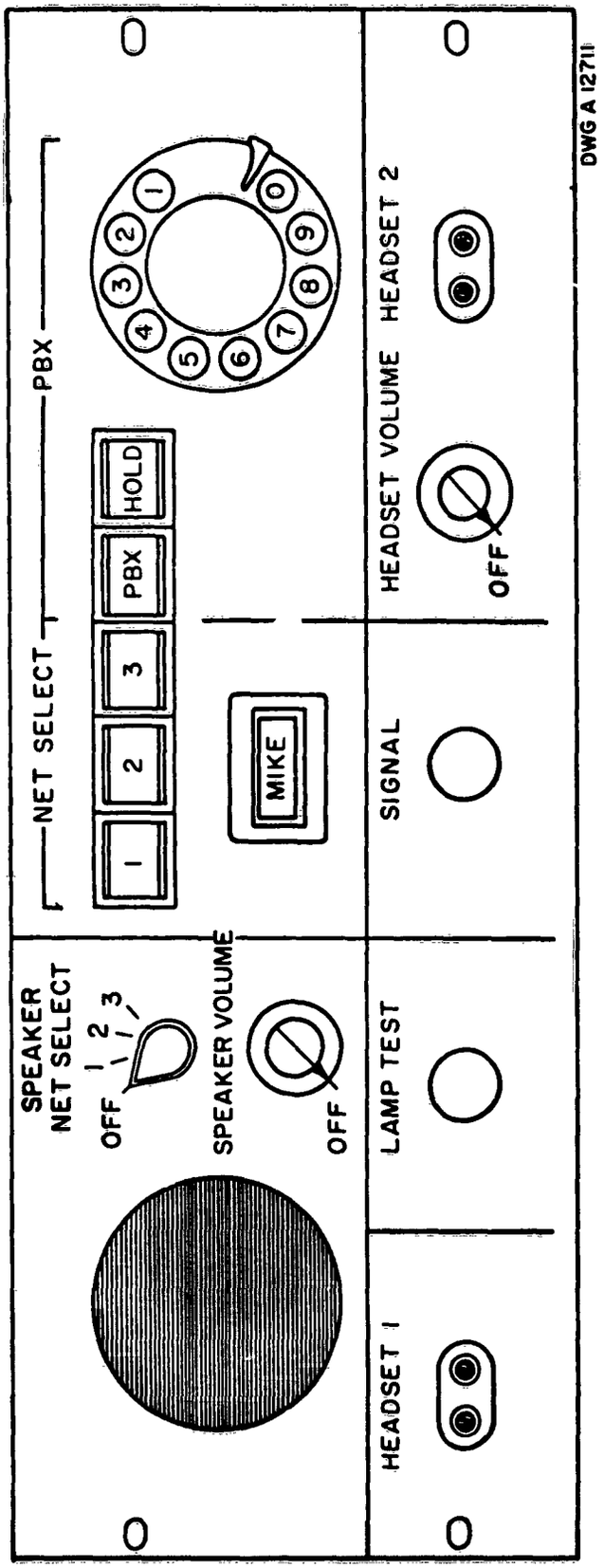


Fig. 5-15 Human Engineered Communication Panel for ATS

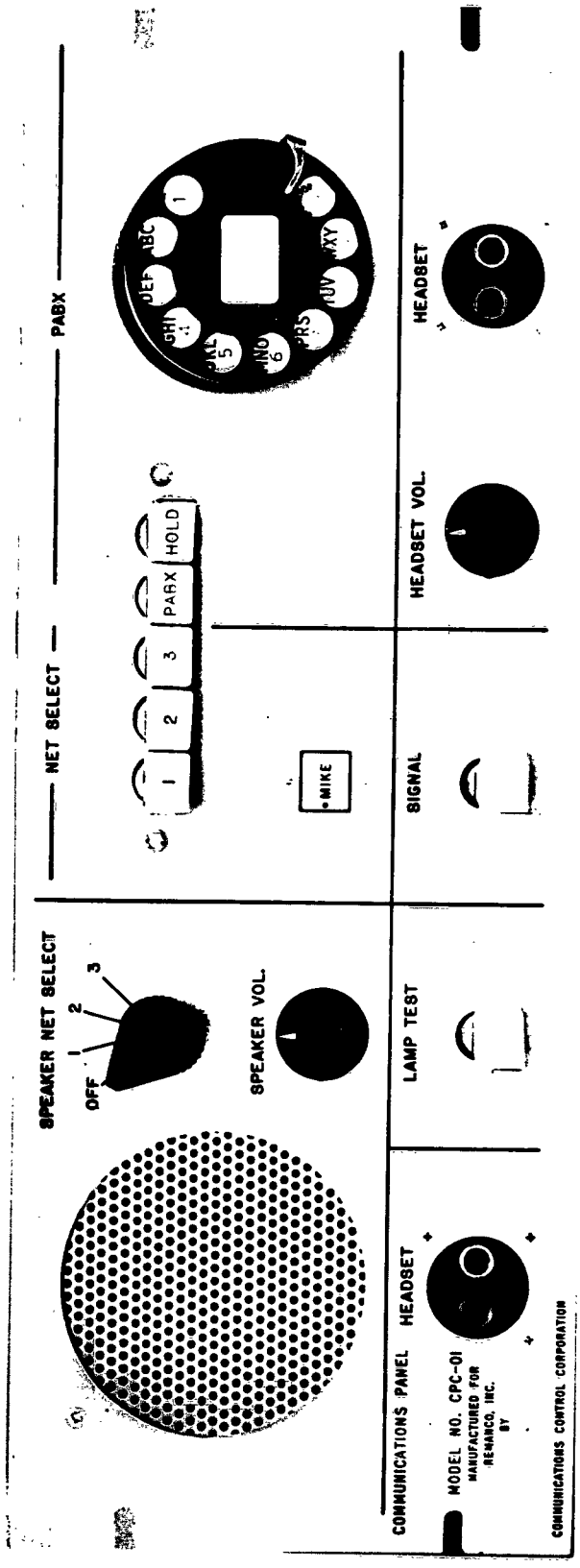


Fig. 5-16 ATS Communication Panel

The communication panels and the communication jackboxes (Fig. 5-17) were used to the fullest capacity during prepass, postpass, and actual operations. All the hardware on the panels and jackboxes proved to be essential for normal operations. No components on the Human-Engineered communication panel proved to be unnecessary. On-station modifications were made on the control positions requiring extra operational capabilities with air/ground communications, the S.T.A., and the antenna pedestals. Figure 5-18 illustrates the communication subsystem for ATS.

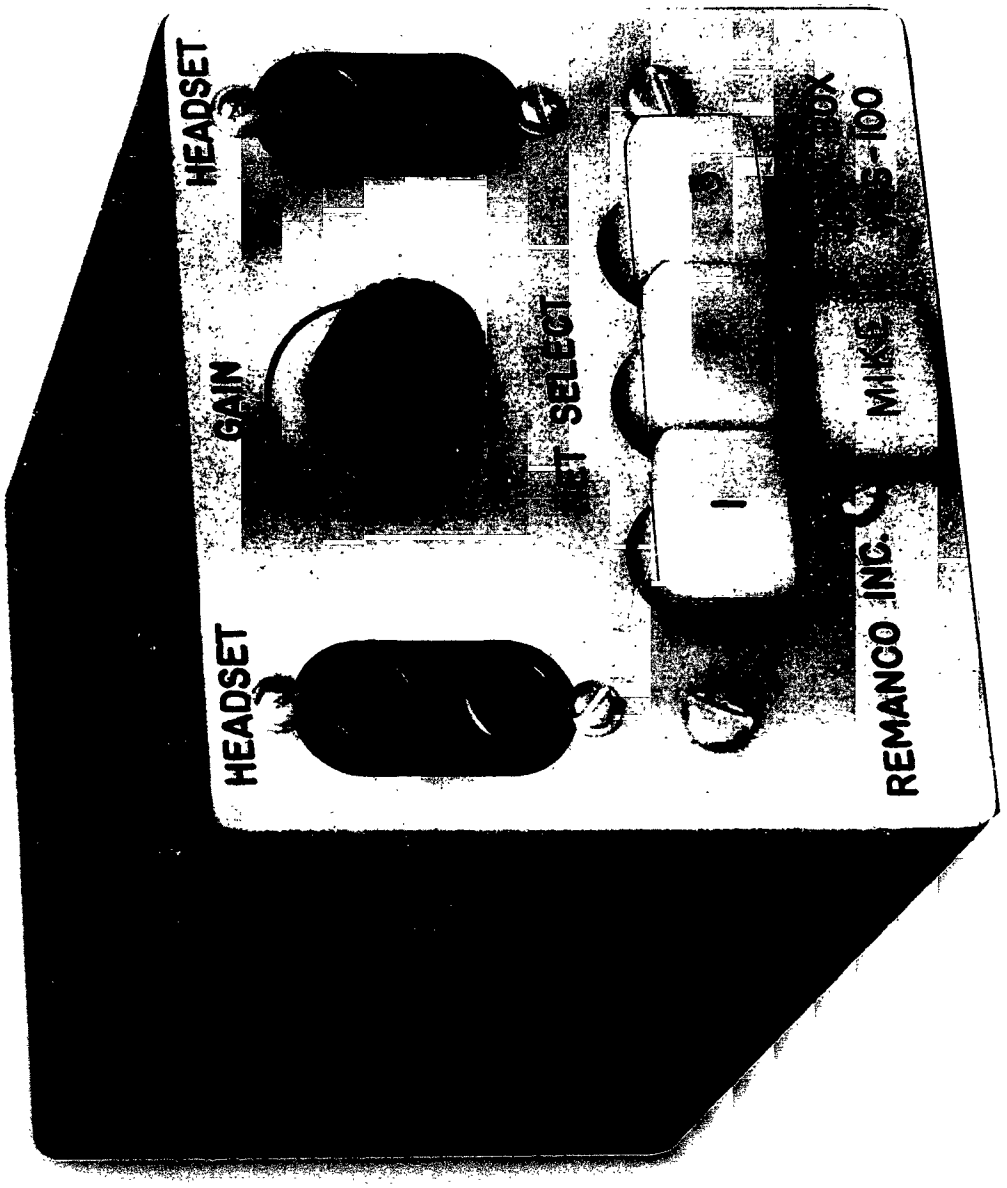
All communication panels and jackboxes are circuited onto three operational nets. Although each of the nets are designated for specific operations, they can be used interchangeably. The third net is used for maintenance, as a spare for handling special requirements, or as a backup in the event the first or second net fails.

The operators felt that the communication equipment was designed well enough that the operation of the equipment was self indicative.

As far as the location of the communication equipment is concerned, there were only four places in which allocation of one more panel and the relocation of two jackboxes and a panel could have facilitated more efficient operation.

The ATS operational communication subsystem consists of the following equipment:

13 panels
8 jackboxes
1 air/ground control
3 air/ground jack outlets
9 sound-powered phones
1 S.T.A. speaker monitor
2 public address controls


HEADSET
GAIN
SELECT
HEADSET
REMANCO INC.
MIKE

AREA	TRANSMITTER																	RECEIVER																							
VAN	COMM		ADMIN. & CONTROL							DATA					RADAR							TELEMETRY					INSTRUMENTATION									M & S					
COMMUNICATION LOCATION	COMMUNICATION		TRACKING CONTROLLER CONSOLE	STATION CONTROLLER CONSOLE	COMMAND CONTROLLER CONSOLE	(G.E. 701)	PLOTBOARD (OUTLET ON END OF OA156)	OPERATOR TURRET		CONTROL, DATA HANDLING	ACQUISITION PROGRAMMER RECORDER	OPERATIONAL VOICE DISTRIBUTION	D-TT CONVERTER		AUXILLIARY CONSOLE	RADAR CONSOLE	ORBITAL COMPUTER	TIMING RACK	RADAR PEDESTAL (RADOME)		DECOMMUTATOR #1	DECOMMUTATOR #2	REMOTE CONTROL ITT SCOPE	VHF RECEIVER MONITOR		UHF EXCITER	TIME CODE WORD GENERATOR	BAFFLE	TEST EQUIPMENT	QUAD HELIX RADOME	ANTENNA SUPPORT STRUCTURE		MAINTENANCE AND STORAGE AREA		
O.A. NUMBER	194		156	155						124	130	132	128								159	151	149	147		140	133	136	138										
COMMUNICATION UNIT TYPE	P		P	P		P@	J	T		P	P		J		J	P	J	J	J		P	P		P			P	P	J	J				P				
P.B.X. EXTENTION NUMBER	30		15	12		11		0		13	14					16					21	18		17			28	27				28			10			
MONITORING FACILITY	+		+	+		+		+		+	+	+				+					+	+		+			+	+							+			
PUBLIC ADDRESS CONTROL						+		+																															

NET

1	TRACKING	X		X	X		X	X			X	X		X		X	X	X	X	X	X			X				X	X	X	X	X			X				
2	COMMAND	X		X	X		X	X			X	X		X		X	X	X	X	X	X			X				X	X	X	X	X			X				
3	MAINTENANCE & CALIBRATION	X		X	X		X	X			X	X		X		X	X	X	X	X	X			X				X	X	X	X	X			X				
	STC	X*		X				X																																
	A/G	X*		X													X																							
	SOUND POWERED PHONE (TMX)			X													X			X																			
	SOUND POWERED PHONE (RCVR)			X																			X			X		X		X									

@ ON ADJOINING RACK.
ALL PANELS (P) HAVE MAINTENANCE JACKS LOCATED IN BACK OF THE PANEL.
J = NET SELECT JACK BOX

Fig. 5-18 ATS Communication Subsystem

2 A.S.R. 28 teletypes

1 operator turret control and ancillary crypto equipment located in seven vans, and antenna structures of both the transmitting and receiving areas (Figs. 5-19 through 5-25).

5.4.2 Communication Panel

The communication panel shown in Fig. 5-16 consists of the following equipment:

1 loudspeaker
2 headset jack outlets
2 volume controls
1 lamp test button
1 signal button
1 PABX dial
1 rotary net select switch
1 microphone indicator light
5 indicator switches

Loudspeaker Monitor

The loudspeaker enables the operator to monitor a net without using a headset. It also provides the capability of monitoring two operational nets or of monitoring an operational net while using the PABX phone. Instead of using the headsets during non-operational periods, the ATS operators usually employed the loudspeaker monitor when working near the communication panels.

Loudspeaker Volume Control

The SPEAKER VOL. control adjusts the loudspeaker output level.

Loudspeaker Net Select Switch

The SPEAKER NET SELECT rotary switch turns on the loudspeaker and enables the selection of three operational communication nets.

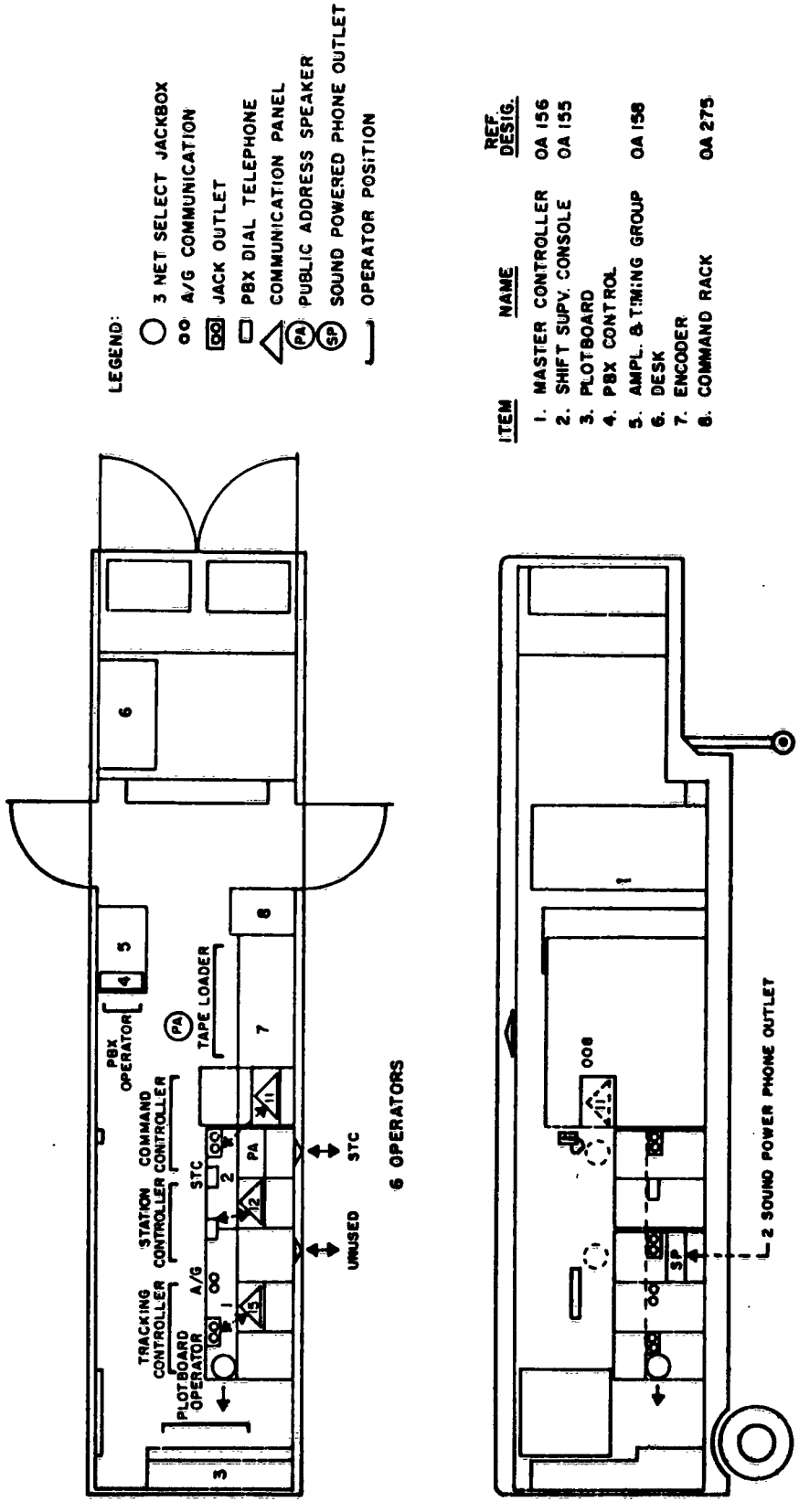


Fig. 5-19 ATS Administration and Control Van

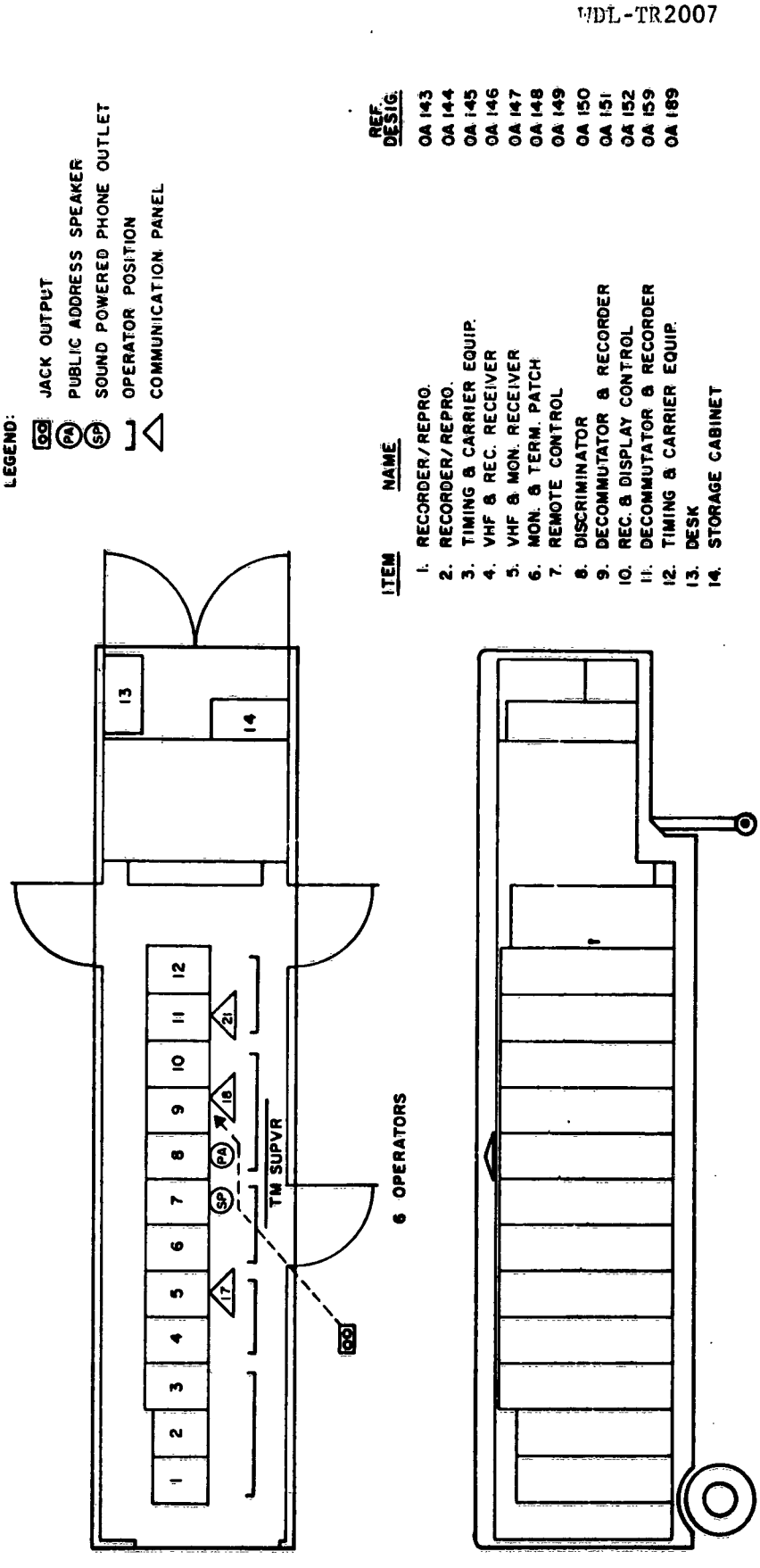


Fig. 5-20 ATS Telemetry Van

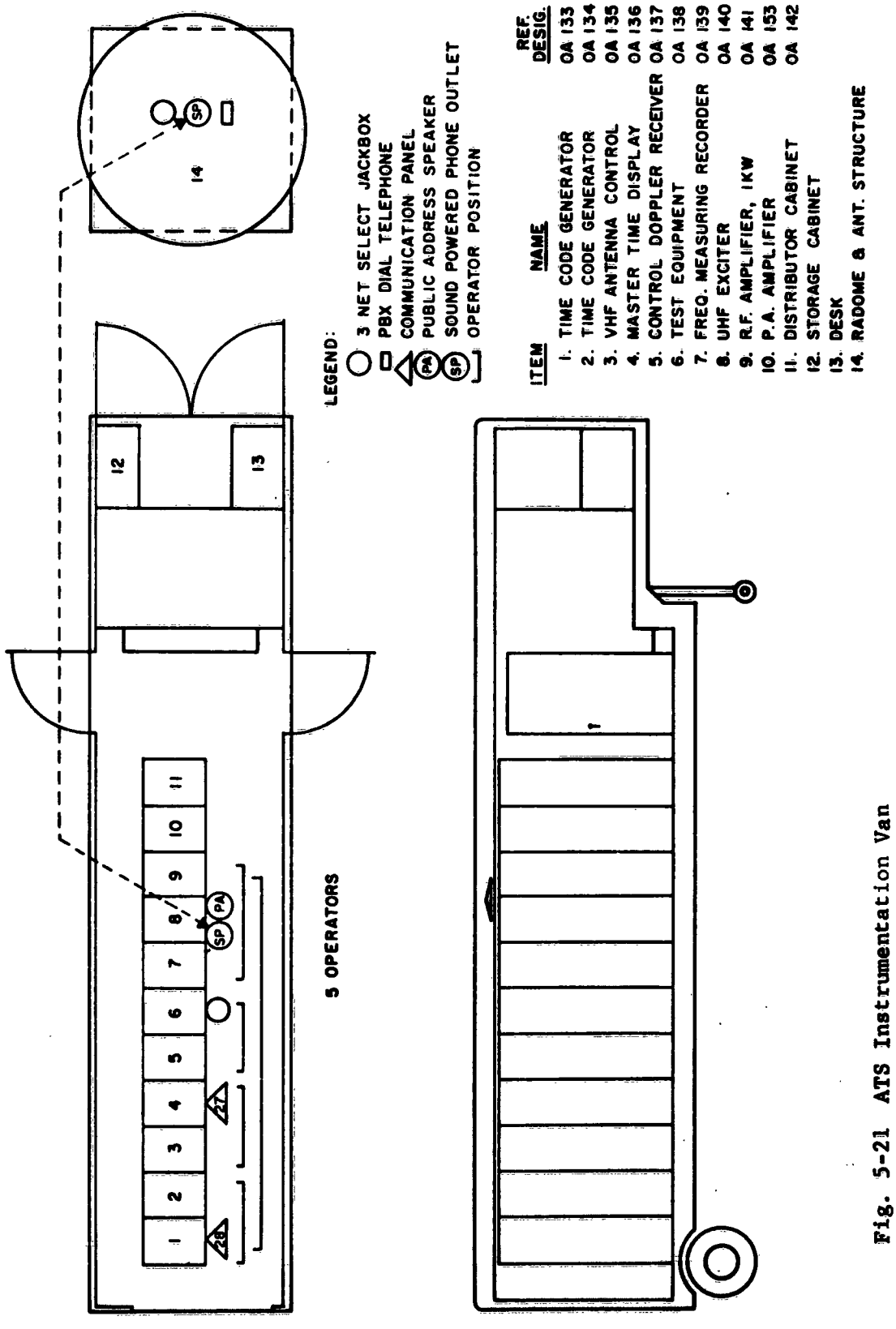


Fig. 5-21 ATS Instrumentation Van

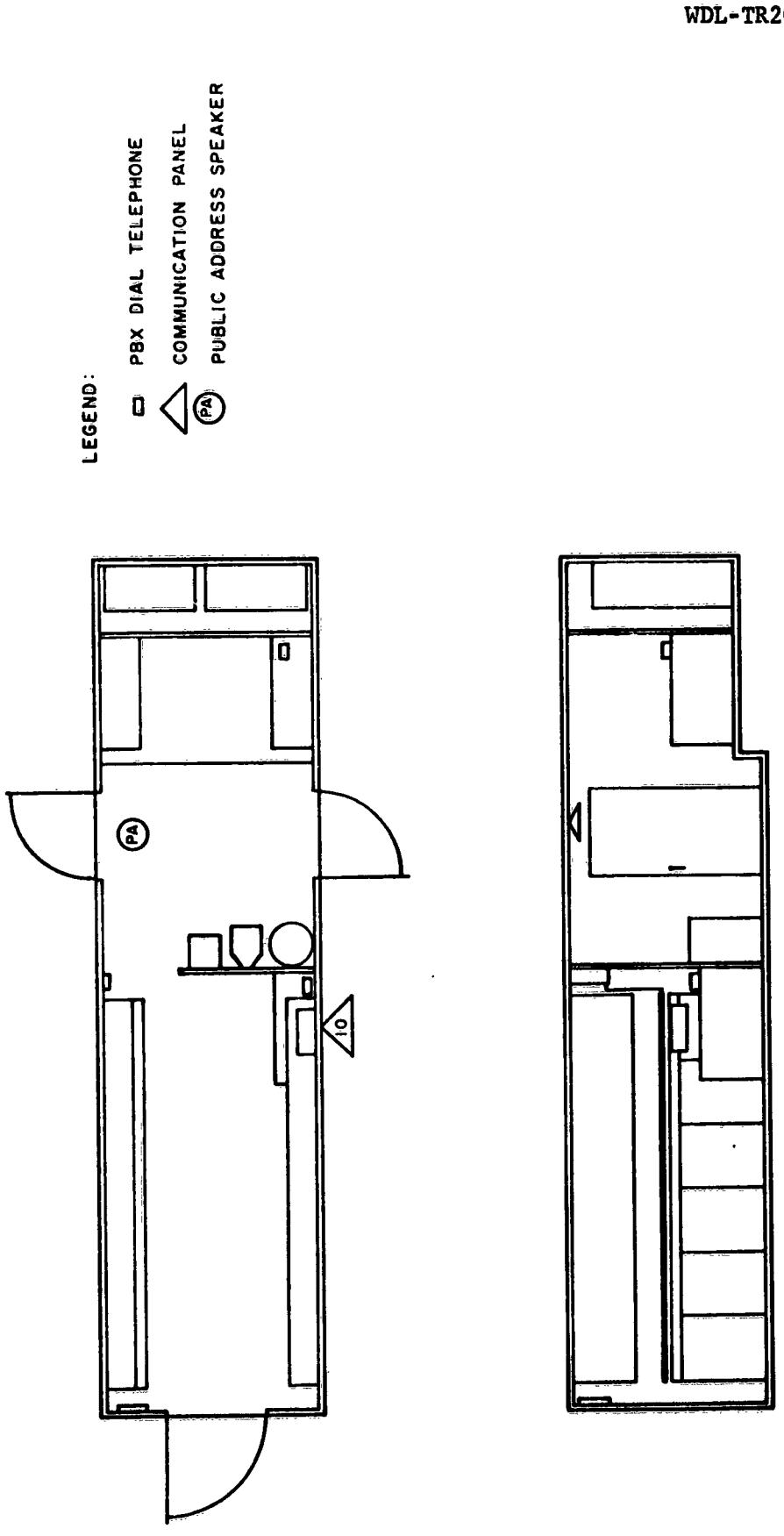
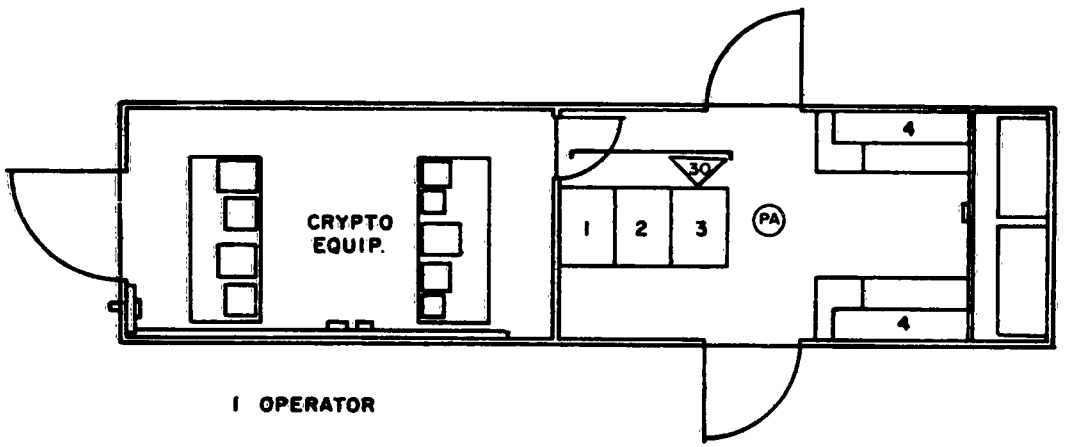
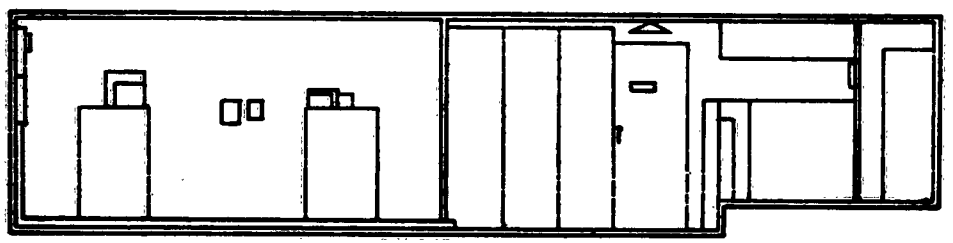


Fig. 5-22 ATS Maintenance and Storage Van



LEGEND:

- COMMUNICATION PANEL
- OPERATOR POSITION
- (PA) PUBLIC ADDRESS



ITEM	NAME	REF. DESIG.
1.	AIR/GROUND #1 EQUIP.	
2.	AIR/GROUND #2 EQUIP.	
3.	COMMUNICATION VOICE CONTROL	OA 194
4.	ASR 28 TELETYPE	

Fig. 5-23 ATS Communication Van

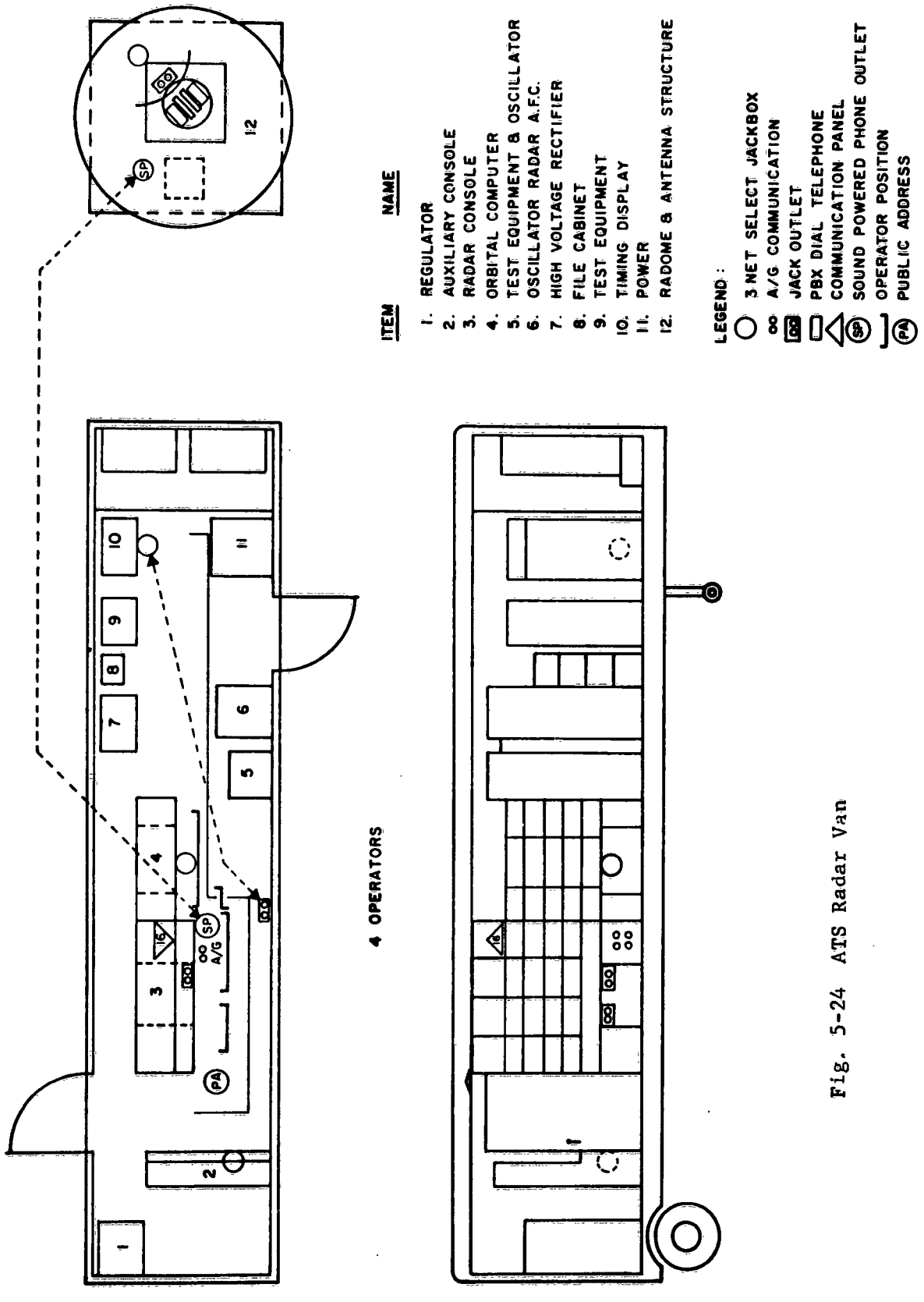
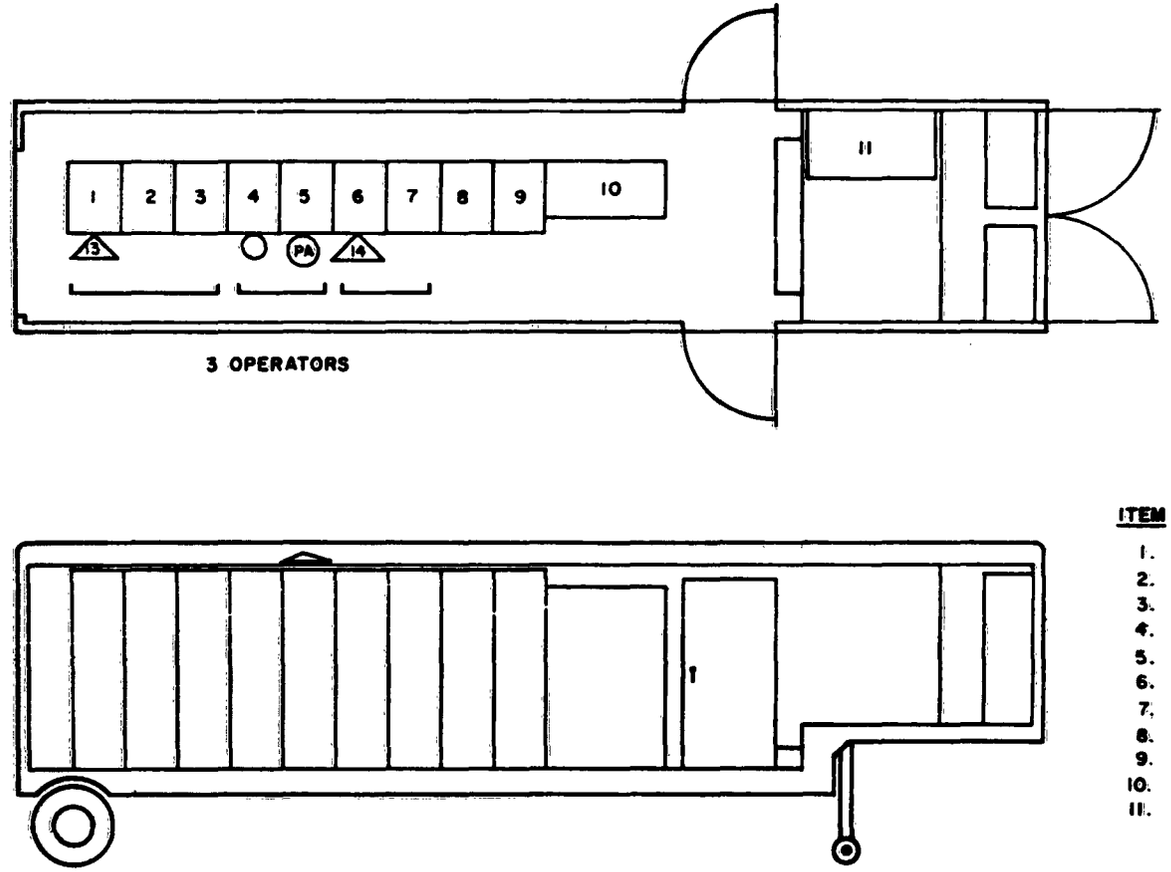


Fig. 5-24 ATS Radar Van



ITEM	NAME	REF. DESIG.
1.	CONTROL DATA HANDLING EQUIP.	OA 124
2.	POLAR TO CARTESIAN CONV.	OA 125
3.	CARTESIAN TO POLAR CONV.	OA 126
4.	D-TT CONV. REC.	OA127
5.	DIGITAL TEL. CONV.	OA 128
6.	ACQUISITION PROGRAMMER REC.	OA 129
7.	ACQUISITION PROGRAMMER	OA 130
8.	INTER-AREA DISTRIBUTOR	OA 131
9.	OPERATIONAL VOICE DISTRIBUTOR	OA 132
10.	PBX SWITCHBOARD	
11.	DESK	

Fig. 5-25 ATS Data Transmission Van

Lamp Test Pushbutton

The LAMP TEST pushbutton enables a quick check of all light indicators on the panel. It is usually employed during a prepass check-out prior to the first orbit operation.

Headset Jack Outlets

Two HEADSET jack outlets are connected in parallel on the communication panel and on the jackbox. The signal gain is adjusted by the HEADSET VOL. control. Another jack outlet is provided on the back of the panel for maintenance, alignment, and calibration purposes. Additional jack outlets connected in parallel with those on existing panels and jackboxes are provided in various station locations (antenna pedestals, radar van, TLM van, etc., as shown in Figs. 5-19 through 5-25).

Net Select Pushbutton Indicators

The NET SELECT pushbutton indicators enable the selection of three operational nets and the PABX line. A HOLD pushbutton indicator is also provided and is used only with PABX calls. Only one net can be selected at a time by pressing the appropriate pushbutton.

Net 1 is the tracking net; and during tracking operations, the following operating positions are assigned:

1. Tracking Controller
2. Tracker
3. Range
4. Radar Computer
5. Data
6. Receivers
7. Recorders
8. Instrumentation

9. Quad Helix
10. Acquisition Programmer
11. Converter
12. Plotboard
13. Timing
14. Teletype
15. Doppler Receiver
16. Doppler Transmitter

Net 2 is the command net; and during commanding operations, the following operating positions are assigned:

1. Command Controller
2. Telemetry Supervisor
3. C.E.C. Recorder
4. Decommutator #1
5. Decommutator #2
6. Radar Supervisor

Net 3 is designated as the maintenance, alignment, calibration, and backup net and is used by certain tracking and commanding positions during prepass and checkout operations. When special requirements are added onto the checkout or fly-by tasks, net 3 is used.

The PABX pushbutton indicator is used for activating the dial phone. Pressing the PABX pushbutton indicator automatically disengages any one of the other four pushbuttons and permits the operator to dial local interstation or intrastation numbers. Headsets are used with the panel PABX dials.

The HOLD pushbutton indicator is used to hold any incoming PABX calls on the outside line without interfering with the operational net in use. The HOLD pushbutton will remain activated until the PABX pushbutton is pressed. The PABX pushbutton is the only switch which will deactivate the HOLD pushbutton.

Mike Indicator

The MIKE indicator lights to show that the microphone of the panel is "on" and transmission is taking place. The MIKE indicator was designed primarily to prevent any open mike conditions. At ATS mike buttons for the headsets have frequently stuck and remained open after normal transmission.

Signal Pushbutton

The signal pushbutton is used for alerting individuals on the selected net with both an audio and visual signal. At ATS, the signal button is put to another use: the station controller uses it, at ETA-45, to alert all the operators in the transmitting and receiving areas at the start of the prepass checkout.

Headset Volume Control

The HEADSET VOL. control adjusts the signal output level for the headsets.

PABX Dial

The PABX dial is used in conjunction with the PABX pushbutton indicator for dialing any local station or outside numbers. In comparison to VTS, much time was saved and extra operations were eliminated from the ATS tracking personnel activities because the PABX dials were activated on all the ATS communication panels. Local outside calls are made by dialing "9" and the outside number. This can be done from any PABX dial phone. Conference calls are made by dialing "81" on the PABX dial phone. A maximum of four persons plus the operator on the operator's turret may dial into the conference call from any dial phone on the station.

5.4.3 Net Select Jackbox

The net select jackbox, shown in Fig. 5-17, has limited capabilities in comparison to the communication panel. The jackboxes were placed in operational positions which did not require the flexibility and capabilities of the communication panel. The hardware mounted on the jackbox consists of the following items:

3 net select pushbutton indicators
1 volume control
2 headset jack outlets
1 "mike" indicator light

5.4.4 Public Address System

The public address (P.A.) system at ATS is a two-zone system (Fig. 5-26). It is activated by dialing "86" from any station PABX dial phone or through the station controller's operational P.A. access panel. The P.A. capability through the access panel overrides the dial-on P.A. capability. The dial-on capability ("86") puts the P.A. system on an entire single-zone system and combines both the tracking and receiving area P.A. nets. The P.A. system loudspeakers are in various locations of both the transmitting and receiving areas, as indicated in Figs. 5-19 through 5-26.

5.4.5 Public Address Access Panel

The public address access panel (Fig. 5-27), located in the console bay between the command controller bay and the station controller bay, is used for controlling the public address system and the alternate voice/teletype line to S.T.C. This panel houses the following items:

1 Mike input jack plug
1 Mike switch jack plug
1 Speaker Test button
3 Net select buttons
3 Toggle switches

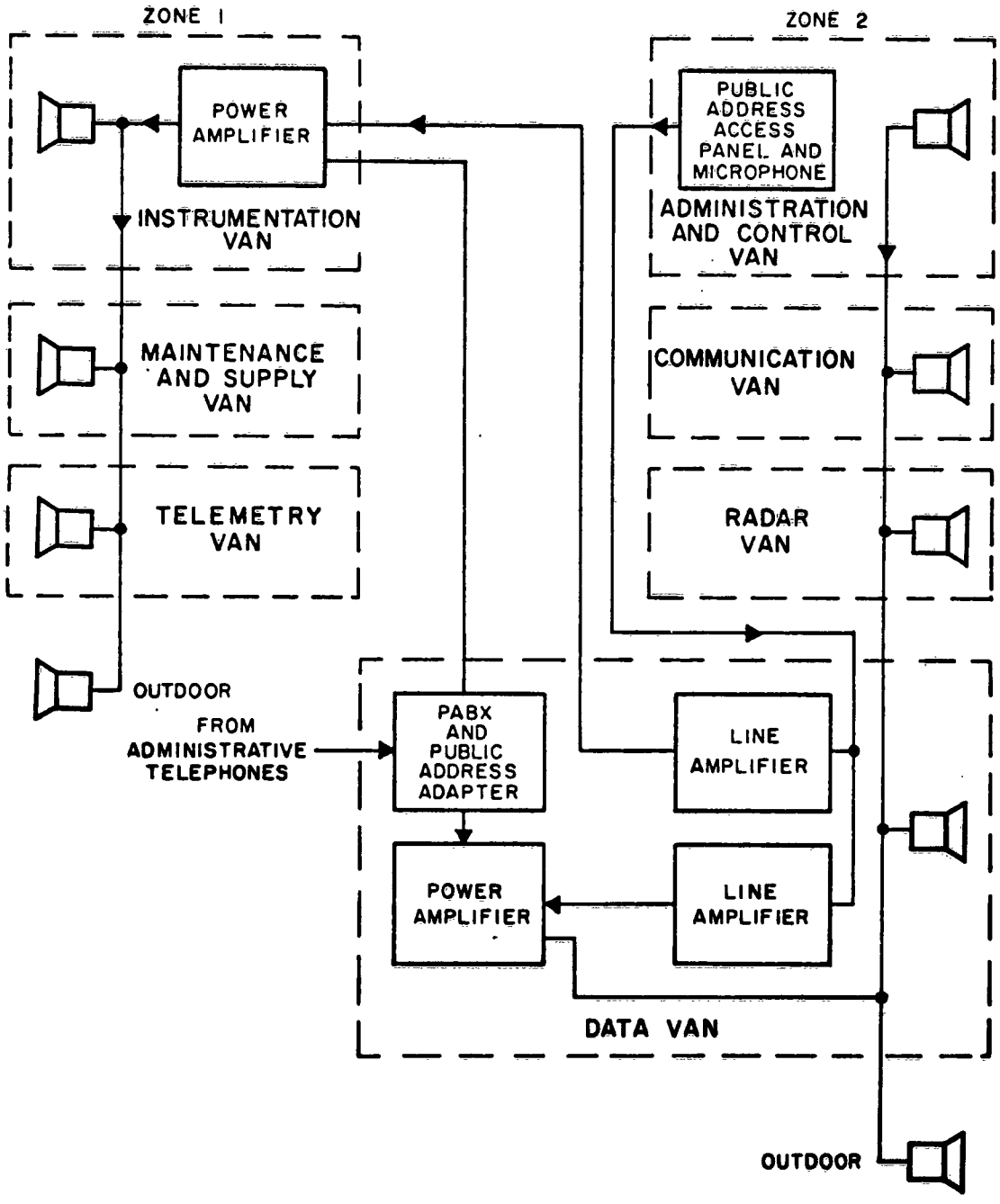


Fig. 5-26 ATS Public Address System

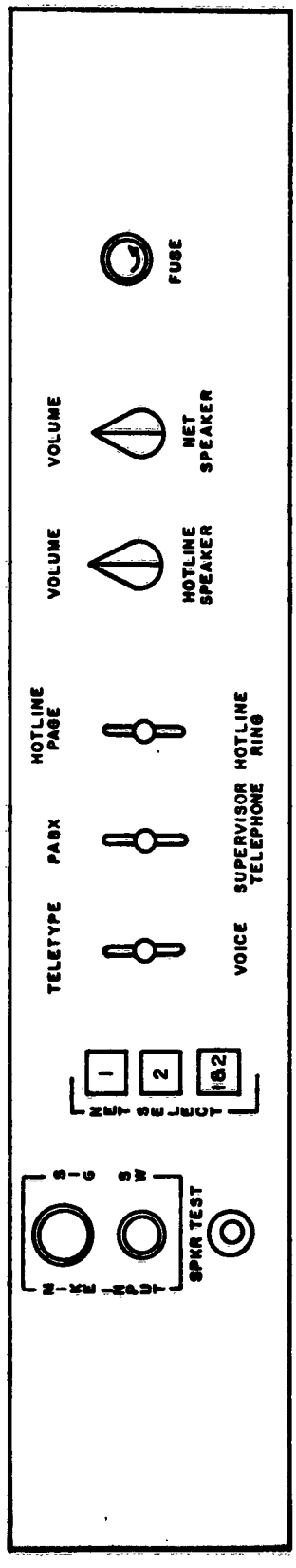


Fig. 5-27 ATS Public Address Access Panel

1 Teletype/Voice

1 PABX/Supervisor telephone

1 Hotline Page/Hotline Ring

2 Volume controls

1 Hotline Speaker

1 Net Speaker

The public address access panel, which was not Human-Engineered, is quite different from the ones used at either NHS or VTS. The ATS system is a two-zone system, whereas the NHS and VTS systems are both ten-zone systems. The ATS two-zone (plus combination of both zones) system has eliminated much of the unnecessary hardware and controls found on both NHS and VTS P.A. access panels.

Mike Jack Plugs

The mike jack plugs are the connecting points for the microphone to the P.A. speaker system.

Speaker Test Pushbutton

The SPKR TEST pushbutton is used to check the P.A. speakers located in both the transmitting and receiving areas. The speakers are tested with the transmission of a high frequency sound over the P.A. system.

P.A. Net Select

The three P.A. NET SELECT pushbuttons are used for selecting the area in which the station controller desires to activate the P.A. system.

Net 1 is used to activate the P.A. system in the transmitting area. Net 2 is used to activate the P.A. system in the receiving area. Net 1 and 2 is used to activate the P.A. system in both the transmitting and receiving areas.

Teletype/Voice Toggle Switch

The TELETYPE/VOICE toggle switch is used for directing the use of the alternate teletype/voice circuit. This circuit is one of the communication links between S.T.A. and ATS and is used for sending teletype tracking data, receiving acquisition messages, or conveying verbal messages to and from S.T.A.

PABX/Supervisor Telephone Toggle Switch

The PABX/SUPERVISOR TELEPHONE toggle switch is used for circuiting the incoming S.T.A. calls onto either the station controller's headset or the station PABX system.

Hotline Page/Hotline Ring Toggle Switch

The HOTLINE PAGE/HOTLINE RING toggle switch is used for circuiting the S.T.C. call in parallel to both the transmitting and receiving area speaker systems. When the toggle switch is switched to the HOTLINE RING position, it signals the control position at S.T.C.

Hotline Speaker Volume Control

The HOTLINE SPEAKER VOLUME control is used for controlling the output signal level of the hotline speaker on the van wall in front of the control console of the A&C van.

Net Speaker Volume Control

The NET SPEAKER VOLUME control is used for controlling the output signal level of the net speaker.

Fuse Holder

The FUSE holder houses the P.A. access panel fuse.

5.4.6 Operator Turret

The operator turret (Fig. 5-28), placed on top of the overhang of the amplifier rack in the A&C van, is used as the station PABX switchboard. The turret houses 70 round indicator switches, 8 twist indicator

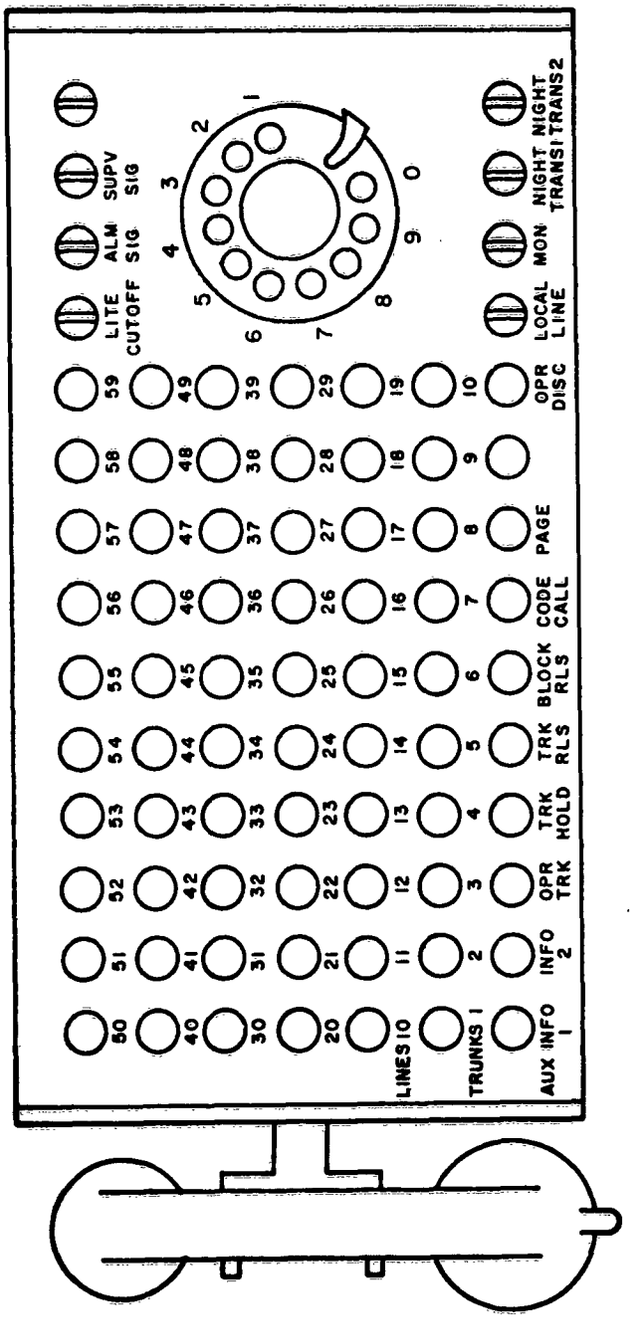


Fig. 5-28 ATS Operator Turret

switches, 1 PABX dial, and 1 handset. The switches and dial of the turret are used as the controls for conferencing, placing long distance calls, paging, holding, connecting incoming calls into station locals, monitoring, and switching operator calls into the living area PABX dial phone during off-duty hours.

The operator's turret should have been located in the communication van (as previously recommended by Human Factors) instead of in the congested A&C van.

5.4.7 Sound-Powered Phones

The sound-powered phones, located in various areas (Figs. 5-19, 5-20, 5-21, and 5-25), are used mainly for antenna maintenance, alignment, and calibration operations. They are never used for tracking or commanding operations.

The sound-powered system is divided into two areas: transmitting and receiving. Each of the independent systems is connected between the antenna structure, antenna, and their respective controls. The only operational position having access to both of the sound-powered nets is located under the overhang of the station controller's console (Fig. 5-29).

5.4.8 Communication Links

The ATS communication links consist of the following (Fig. 5-30):

1 Teletype line to S.T.C. (100 wpm)
1 Alternate voice/teletype line to S.T.C. (100 wpm)
1 Air/ground communication (transmit and receive)
2 PABX long-distance trunks

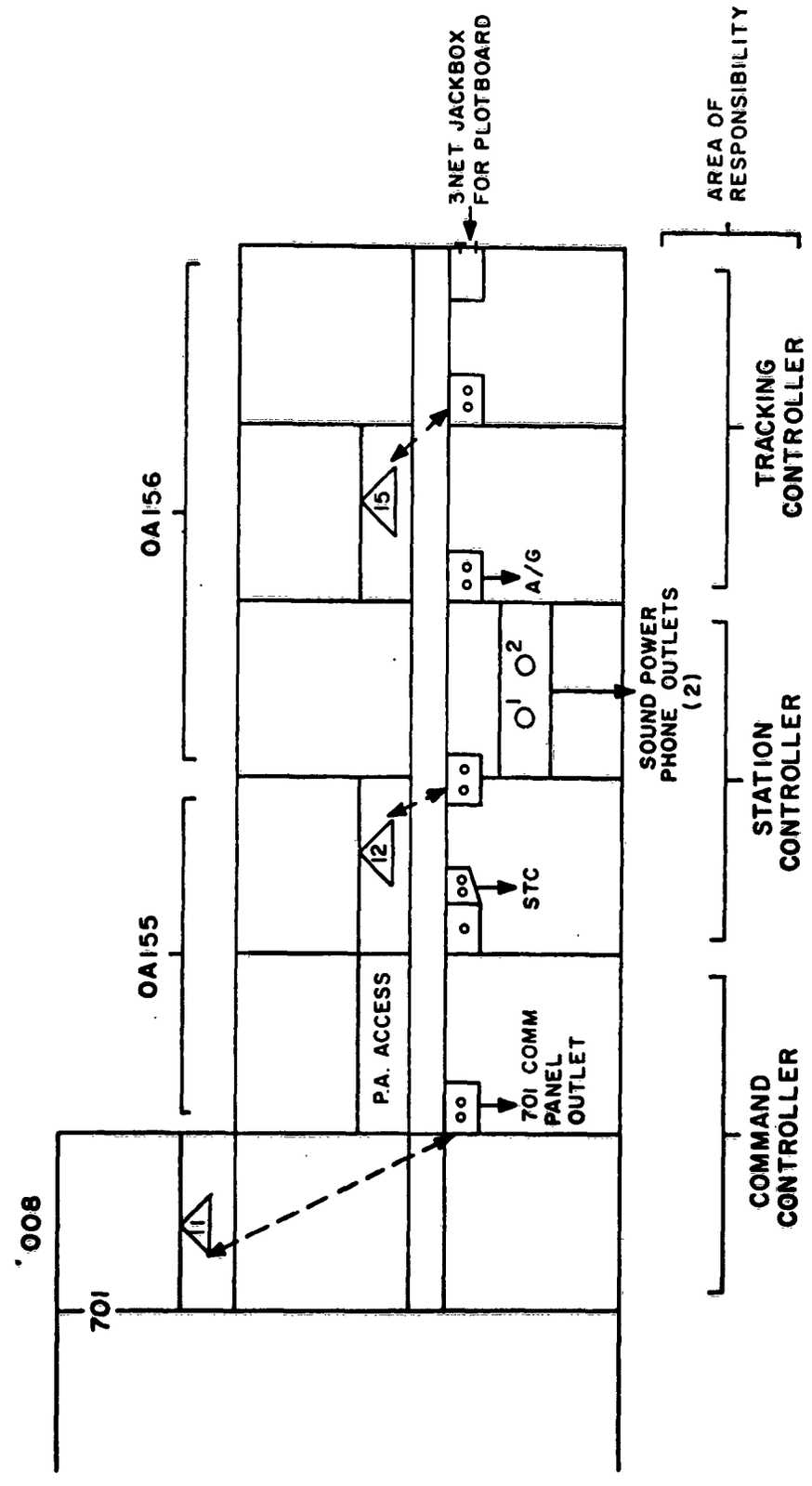


Fig. 5-29 ATS Control Console Communication Equipment Location

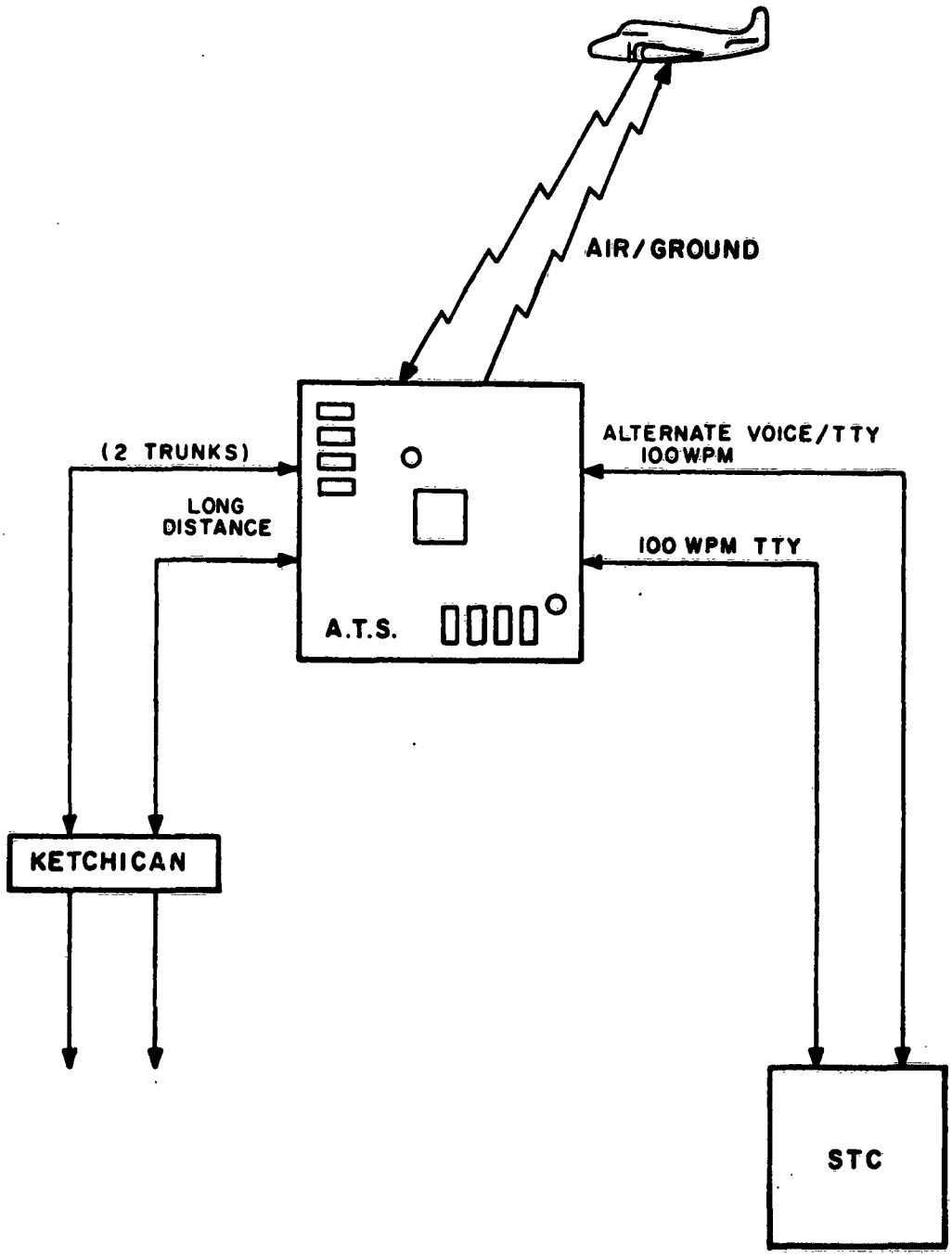


Fig. 5-30 ATS Communications Links

100 wpm Teletype

The 100 wpm teletype line sends and receives data to and from S.T.C. and is used mostly as a date link. The teletype equipment which sends this data is an A.S.R. 28 located in the communication van.

Alternate Voice/Teletype

The alternate voice/teletype line to S.T.C. is also a 100 wpm line. It is used for transmitting and receiving administrative as well as operational messages. The controlling switch determining the mode of transmission or reception is located on the Public Address access panel (TELETYPE/VOICE toggle switch). When the voice portion of the alternate voice/teletype system is being used, the transmission and reception of teletype messages are handled on the second A.S.R. 28 in the communication van.

Air/Ground Communication

The air/ground communication is conducted over government-furnished equipment (G.F.E.) consisting of AN/GRT 3 and AN/GRR 7 located in the communications van (Fig. 5-23).

The fly-by operations are conducted over the air/ground equipment to calibrate and check out ground station telemetry and tracking equipment.

PABX Long Distance (Long Lines)

The PABX long distance calls are made through Ketchikan. There are two trunks available for making administrative or operational calls. These two trunks are also the back-up lines for voice transmissions to S.T.C. in event the alternate voice/teletype link fails.

5.4.9 ATS Communication Equipment Locations

The ATS communication equipment locations were excellent, except for four locations: three in the radar van and one in the instrumentation van.

To satisfy the added requirements for the instrumentation van, on-station modifications were made by circuiting an additional jack outlet parallel to the existing communication equipment in the required area.

Two jackboxes and one communication panel were installed in non-recommended locations of the radar van. One jackbox was mounted under the orbital computer console, and the other mounted as the bottom panel of the timing rack located in the rear of the radar van.

The main communication panel of the radar van was positioned (after console fabrication) 74 in. above the floor on top of the radar console, which was the only possible area in which it could have been mounted. It is impossible for the operator to make any changes in communication operations from the normal seated operating position. The jackbox mounted under the orbital computer is recessed, located 12 in. off the van floor, and cannot be seen by a standing operator. The operation of this jackbox is quite awkward because of the excessive stooping required to depress the net select button or to plug the headset into the jack outlet.

The jackbox mounted as a panel of the timing rack in the rear of the radar van is in a location only 18 in. off the van floor. At times, test equipment left on the floor in front of this panel would completely obscure the three-net select jack panel. A parallel jack outlet, slaved to this three-net jack panel, is located on the van wall 77 in. off the floor behind the orbital computer. This jack outlet is used by the orbital computer operator instead of the assigned three-net jackbox under the orbital computer. The solution to this problem would be to mount the jackbox on top of the orbital computer (as originally recommended by Human Factors Engineering).

The same condition exists for the jackbox mounted on the panel spaces above the backbox panel: no effort is being made to move the jackbox panel into a more operable location as recommended by Human Factors.

The positioning of the operator turret in back of the G.E. 701 operator position in the A&C van was not recommended by Human Factors Engineering. Because the turret is located in such a position, the command rack transistorized boards have limited access for maintenance.

Since the jackbox relocations would require field modification change orders, the operators are satisfying their operational communication requirements by using other available jack outlets as substitutes.

5.4.10 Recommendations

The following recommendations are made by Human Factors Engineering:

a. The present voice communication subsystem was designed and developed prior to the compliance date of AF/SSD 62-44A "Human Engineering for the Air Force Satellite Control System", dated 1 July 1962. As a result, only MIL-STD-803 was used as a design guide. Therefore, functional and task analyses as well as a design assurance activity should be performed.

b. When operational equipment is moved out of prime rack or console control areas, control panels or communication equipment in outlying rack-console areas should be moved into the vacant areas.

c. On-station hardware modification requests should be handled in an expeditious manner and released as soon as possible for on-station implementation.

d. Request for communication modifications on-stations should come directly through Human Factors Engineering so that immediate action can be taken or coordinated.

e. In order to alleviate the congested A&C van situation, the operator turret and operator should be moved into the communication van, thus providing more working space for the console operators.

f. The operator turret should have a "lamp test" switch for checking all of the 78 indicators and a volume control for the handset. (The operator cannot hear well when the G.E. 701 tape system is operating.)

g. If a Reeves type radar console is to be used for future programs, a location for a communication panel should be designed into the controlling area of the console.

h. Closer contact should be established between the communication equipment manufacturer and Human Factors Engineering during the initial design and pre-production phases of the product. This will help to prevent the incorporation of any undesired, non-standard hardware in the ordered equipment and would result in a product representative of the Human Factors Engineering effort.

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